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CONTENTS

Contents continued on inside cover.

Contents (cont.)

NOTES ON *SICYOS* (CUCURBITACEAE) IN THE HAWAIIAN ISLANDS

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ABSTRACT

Nomenclature and taxonomy of *Sicyos* L. in Hawai'i are clarified as a precursor to the *Manual of Flowering Plants of Hawai'i*. *Sarz* H. St. John is reduced to synonymy under *Sicyos*. New combinations **Sicyos herbstii** (H. St. John) Telford and **Sicyos alba** (H. St. John) Telford are made and *Sicyos hillebrandii* var. *anunu* H. St. John given new status as **S. anunu** (H. St. John) Telford. *Sicyos pachycarpus* Hook. & Arn. is lectotypified and shown to be the correct name for the species known as *S. microcarpus* H. Mann.

KEY WORDS: Hawai'i, *Sicyos herbstii, Sicyos alba, Sicyos anunu, Sicyos pachycarpus*, lectotypification.

INTRODUCTION

In Hillebrand's *Flora of the Hawaiian Islands* (1888, p 134), *Sicyos* L. was treated as the only indigenous genus of Cucurbitaceae with 8 endemic species. Since then, 5 genera have been segregated from *Sicyos* in Hawai'i and an additional 48 taxa described in *Sicyos* or its segregate genera.

The delimitation of the segregate genera on fruit ornamentation was questioned by Jeffrey (1978, p 361). His conclusion that they are congeneric is followed and developed in this paper.

As a precursor to the *Manual of the Flowering Plants of Hawai'i* (Wagner *et al.*, in press), this paper attempts to resolve some problems of taxonomy and nomenclature in Hawaiian Cucurbitaceae.

Status of the segregate genera.

As discussed by Jeffrey (1978, p 361), four of the genera segregated from *Sicyos*, namely *Cladocarpa* (H. St. John) H. St. John (1978b, p 491), *Sicyocarya* (A. Gray) H. St. John (1978a, p 407) and *Skottsbergiliana* H. St. John (1974, p 457), are better treated at sectional rank at most. All are consistent with the vegetative and floral syndromes of *Sicyos*, differing only in the fruit morphology which characterizes the sections.

The following new combination transfers a recently described species from *Cladocarpa* into *Sicyos*.

209

Sicyos herbstii (H. St. John) Telford, *comb. nov.* BASIONYM: *Cladocarpa herbstii* H. St. John, Phytologia 63:185. 1987. TYPE: Hawaiian Is., Kaua'i, Barking Sands, *D. Herbst 5691* (HOLOTYPE: BISH).

Cladocarpa julesii H. St. John, Phytologia 63:185. 1987. TYPE: Kaua'i, *J. Remy 542* (HOLOTYPE: P).

Cladocarpa pauciramosa H. St. John, Phytologia 63:186. 1987. TYPE: Kaua'i, Polihale, *C. Christensen 326* (HOLOTYPE: BISH).

The single species of the fifth segregate genus, *Sarx alba* H. St. John (1978b, p 491) was segregated from *Sicyos cucumerinus* A. Gray because of its white fleshy fruit, despite mature fruit of *S. cucumerinus* being "still unknown." St. John relegated Gray's *S. cucumerinus* var. *B* to synonymy under *Sarx*. Recently collected fruit specimens of *S. cucumerinus* have been examined at BISH by the present author and the texture of the pericarp proved to be subfleshy. Certainly the character of fleshy fruit alone is untenable for generic segregation. This taxonomic view of *Sarx* in relation to *Sicyos* conforms with the treatment of *Sechium* P. Br. by Jeffrey (1978, p 360). In *Sechium* also, the pericarp may be fleshy, fibrous or woody.

A new combination is provided below for *Sarx alba* in *Sicyos*.

Sicyos alba (H. St. John) Telford, *comb. nov.* BASIONYM: *Sarx alba* H. St. John, Bot. Jahrb. Syst. 99:493. 1978. TYPE: Hawai'i, Kulani, *W. Gagne 698* (BISH).

Vegetatively and in floral morphology, *Sicyos cucumerinus* and *Sarx alba* are so similar that not only generic but also specific separation must be questioned. Field studies and additional collections of the two species are required before resolution of the species delimitation problem is attempted.

The identity of *Sicyos pachycarpus*.

The first species of *Sicyos* collected and named from the Hawaiian Islands was *S. pachycarpus* Hooker & Arn. (1832, p 83), collected by Collie on Diamond Head, O'ahu in 1826-27. A. Gray (1854, p 650, t. 80), in his study of the U.S. Exploring Expedition's collections of 1840, misapplied the name *S. pachycarpus* to an as yet undescribed species from the Wai'anae Mountains, O'ahu. The specimen of *S. pachycarpus sensu* Gray lies far outside the circumscription of Hooker & Arnott's protologue. Gray must not have seen Collie's type collection housed at Kew.

Cogniaux (1881, p 896) followed Gray's misapplication and compounded it by citing more specimens. Hillebrand (1888, p 137) recognized a problem existed: "It is somewhat doubtful, however, if Gray's *S. pachycarpus* is the

same as that of Hooker & Arnott, for the latter authors assign a height of only 1 1/2-2″ to their fruit, which points to *S. microcarpa*." Unfortunately, Hillebrand did not resolve the problem but instead also followed Gray's misapplication.

Collie's type gathering of *S. pachycarpus* raises another problem. The herbarium sheet at Kew originally consisted of two elements - one of these has been annotated by St. John as *S. microcarpus* H. Mann, the other as the lectotype (unpublished) of *S. pachycarpus* Hook. & Arn. The '*S. microcarpus*' element has been remounted on a separate sheet.

Hooker & Arnott's protologue agrees better with St. John's '*S. microcarpus*' element than with that proposed by him for lectotypification - 'female flowers are numerous in each capitulum...the capitulum itself is on a peduncle, about three-fourths of an inch long...fruit is ovate, about a line and a half long, suddenly attenuated into a beak which is almost half the length of the broad portion'.

The other element, i.e. St. John's '*S. pachycarpus*' element, differs in fewer female flowers per head, the peduncles longer and more slender, the fruit not so abruptly contracted before the attenuation. This element belongs in *S. waimanaloensis* H. St. John (1987, p 192) and is readily distinguished from *S. pachycarpus* by the slower expansion of the leaf laminas as well as the characters above. The two species are sympatric in eastern O'ahu.

The '*S. microcarpus*' element is here proposed as lectotype of *S. pachycarpus*.

Sicyos pachycarpus Hook. & Arn., Bot. Beechey Voy. 3, Sandwich Is.: 83.
     1832. LECTOTYPE (here designated): Diamond Hill, O'ahu, *Collie*
     (K).

S. microcarpus H. Mann, Proc. Amer. Acad. Arts 7:167. 1867.

The identity of *Sicyos hillebrandii*.

The name *S. hillebrandii* H. St. John (1934, p 7), based on *S. laciniatus* Hillebr. (1888, p 138) non L. (1753, p 1013), with the type from Kula, Maui, has been applied to few collections from Maui and to those from several populations on Hawai'i. The Hawaiian material differs from the type in several character states - staminate flowers 5-8 mm diameter; staminate inflorescences on peduncles 12-30 cm long; pistillate flower heads on peduncles 4-12 cm long; fruit 15-20 mm long, as well as geographic separation, but has hitherto been recognized only at varietal rank. It is here raised to the status of species.

Sicyos anunu (H. St. John) Telford, *stat. nov.* BASIONYM: *S. hillebrandii*
     H. St. John var. *anunu* H. St. John, Phytologia 63:187. 1987. TYPE:
     Hawai'i Is., Kapapala, *C.N. Forbes 400.H* (HOLOTYPE: BISH).

S. hillebrandii H. St. John var. *douglasii* H. St. John, Phytologia 63:187.
1987. TYPE: Hawai'i Is., N, slope Mauna Kea, *O. Degener & Greenwall
21,364* (HOLOTYPE: BISH).

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LINDERA SUBCORIACEA (LAURACEAE) NEW TO ALABAMA

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ABSTRACT

Lindera subcoriacea, a candidate species for listing as federally endangered or threatened by the U.S. Fish and Wildlife Service, is reported new to Alabama. Its habitat in Alabama is discussed in relation to habitats for this species in adjacent southern Mississippi.

KEY WORDS: Rare plants, *Lindera subcoriacea*, Lauraceae, Alabama.

In 1983, *Lindera subcoriacea* B.E. Wofford was described as a new species restricted to evergreen shrub bogs in southern Mississippi and adjacent southeastern Louisiana (Wofford 1983). More recently, several populations have been discovered in the sandhills region of North Carolina by Julie Moore of the N.C. Dept. of Natural Resources, and in South Carolina and Georgia by Robert B. McCartney of Aiken, South Carolina. Additional surveys by the Mississippi Natural Heritage Program have resulted in a total of at least 17 localities in that state. After concerted search efforts in North Carolina, South Carolina, Mississippi, Georgia and Louisiana, *Lindera subcoriacea* is now known from a total of 34 sites. It has been predicted to occur in Alabama but apparently has never before been found in the state (Gordon *et al.* 1986). While surveying potential seepage bogs identified by the authors through using soil survey aerial photographs to predict natural community types, we added Alabama to the range of this rare, distinctive shrub. The collection data are as follows:

Lindera subcoriacea B.E. Wofford (Lauraceae). UNITED STATES. Alabama: Mobile Co.: hillside seepage shrub-herb bog on S side of Beverly-Jefferies Rd (Co Rd 96), 7.1 mi W of int. US 45 in Citronelle, 1.3 mi W of Ramey Rd and 1.6 mi E of Escatawpa River bridge; NWQ, SWQ, NEQ, NEQ, Sec. 2, T1N, R4W, Citronelle West 7.5′ Quad., 31° 04′ 49″ N, 88° 21′ 04″ W, elev. 160-180 ft., 15 May 1989, *Orzell & Bridges 9960* (FSU,MISSA,MO,NCU, SMU,TEX,VDB).

Lindera subcoriacea is occasional in partial shade of evergreen shrub-tree thickets within an extensive series of mid-slope hillside seepage bogs. Associated species include *Persea palustris, Magnolia virginiana, Gaylussacia*

mosieri, Ilex coriacea, Myrica heterophylla, Myrica inodora, Smilax laurifolia, Nyssa sylvatica var. *biflora, Rhus vernix, Pyrus arbutifolia* and *Osmunda cinnamomea.* Although many typical open seepage bog plants (*Sarracenia* spp., *Rhynchospora* spp., *Xyris* spp., Eriocaulaceae, Orchidaceae) occur within the seepage bogs at the site, they are not found in the immediate vicinity of *Lindera subcoriacea.* These habitats and associates are very similar to those reported from adjacent southern Mississippi (Wofford 1983; Gordon *et al.* 1986), and include the constant rangewide associates *Magnolia virginiana, Myrica heterophylla* and *Rhus vernix* (Gordon *et al.* 1986).

This record brings the number of *Lindera* species in Alabama to three. *Lindera benzoin* (L.) Blume is common in north Alabama, but infrequent southward, reaching southwest to Sumter, Marengo and Conecuh counties (Clark 1971), all at least 100 km from the Mobile County site for *L. subcoriacea.* Similarly, in Mississippi the ranges of these two taxa are separated by at least 120 km (Wofford 1983). In Alabama, *Lindera melissifolia* (Walt.) Blume, is known only from a single 19th century Buckley collection from Wilcox County (Clark 1971; Wofford 1983). *Lindera subcoriacea* differs from these by its faint aroma and elliptic to oblanceolate, subcoriaceous leaves with obtuse to rounded tips (Wofford 1983).

The flora and natural community ecology of the Gulf Coastal Plain of the southeastern United States remains inadequately studied and understood. This region undoubtedly still harbors many significant plant records. We have noted that many species of the Gulf coastal states which were previously known from very few collections, and presumed to be naturally very rare, are actually locally common in naturally restricted and isolated specific habitats. Systematic field work needs to be focused on this region while the opportunity remains to uncover previously unknown species populations and natural areas. Thirty meters from our *Lindera* site the landscape is being cleared and many significant plant records and natural areas are vanishing each year before being documented.

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CAREX WALTERIANA (CYPERACEAE) AND *EUPHORBIA INUNDATA* (EUPHORBIACEAE) NEW TO MISSISSIPPI

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ABSTRACT

Carex walteriana and *Euphorbia inundata* are reported for the first time in the published literature on the flora of Mississippi. Both are found in wetland savannas on the outer coastal terraces of Jackson County. These sites are the westernmost known for both species. Their habitats and range disjunctions are related to their rangewide distribution and ecology.

KEY WORDS: Mississippi, *Carex*, *Euphorbia*, floristics.

Norquist (1984) discovered two species that were apparently unreported for Mississippi while conducting field work for a comparative study of the soils and vegetation of savannas in the state. Although Ms. Norquist suggested in 1988 that the authors could report her records, we waited until we had independently, without knowing the previous specific locations, found these species in the state. The collection data are as follows:

Carex walteriana Bailey (Cyperaceae). UNITED STATES. Mississippi: Jackson Co.: low pond cypress drainage swale on S side of US 90 at crossing of Franklin Creek, 0.1 mi W of Alabama state line, and 1.4 mi NE of int. Franklin Creek Rd exit from I-10; NWQ, NWQ, NEQ, Sec. 5, T7S, R4W, Kreole 7.5′ Quad., 30° 28′ 20″ N, 88° 24′ 08″ W, elev. 10 ft., 16 May 1989, *Orzell & Bridges 10093* (MISSA,MO,NCU,TEX).

The canopy dominant of this *Carex walteriana* site is *Taxodium ascendens*, with *Acer rubrum*, *Magnolia virginiana* and *Nyssa sylvatica* var. *biflora*. *Carex walteriana* dominates the herb layer, with subdominants *Ludwigia sphaerocarpa* and *Smilax walteri*. Other herbaceous associates include *Eriocaulon decangulare*, *Ludwigia microcarpa*, *Osmunda regalis*, *Panicum hemitomon*, *Rhynchospora corniculata*, *Woodwardia areolata* and *W. virginica*.

Carex walteriana is a common species of wet pond cypress or swamp black gum ponds, depressions and swales, and the edges of evergreen shrub-tree bogs and swamps. It ranges on the Atlantic and East Gulf Coastal Plains from the panhandle of Florida north to Massachusetts. The nearest records

to Mississippi are in Geneva County, Alabama [*Kral 38642; McDaniel 8918* (VDB)] and in Okaloosa and Santa Rosa counties, Florida (Wilhelm 1984). *Carex walteriana* appears to be quite rare west of the Apalachicola River, although it is fairly frequent west to southwestern Georgia and in Florida to the Apalachicola National Forest. The author has collected *C. walteriana* in habitats similar to the Mississippi site in Liberty and Wakulla counties, Florida but has not seen it in apparently suitable habitats farther west in the Florida panhandle and southern Alabama. The Mississippi site is at least 120 km west of the nearest isolated station and 330 km west of the more continuous range.

Euphorbia inundata Torr. *ex* Chapm. (Euphorbiaceae). UNITED STATES. Mississippi: Jackson Co.: wetland longleaf pine savanna on W side of Martin Bluff Rd, 0.1-0.2 mi S of I-10 bridge, ca 3 mi N of Gautier and 1.5 mi E of Gautier-Vancleve Rd int. with I-10; NEQ, NEQ, SEQ, Sec. 13 (or SE part Sec. 37), T7S, R7W, Gautier North 7.5' Quad., 30° 26' 07" N, 88° 37' 55" W, elev. 25 ft., 16 May 1989, *Orzell & Bridges 10101* (MISSA,TEX); acid low pine woods, ca 3 mi E of Ocean Springs, coastal flatwoods, 29 Apr 1967, *S.B. Jones 11879* (VDB).

Euphorbia inundata is found in open, generally treeless low swales within wetland longleaf pine savannas. Associated species include *Aletris lutea, Calopogon pallidus, Centella asiatica, Chaptalia tomentosa, Ctenium aromaticum, Dichromena latifolia, Drosera capillaris, D. tracyi, Eriocaulon compressum, E. decangulare, Helianthus heterophyllus, Hypericum myrtifolium, Lophiola aurea, Lycopodium alopecuroides, Rhexia alifanus, R. lutea, Rhynchospora baldwinii, R. oligantha, R. plumosa, Sarracenia alata, S. psittacina, Scleria baldwinii* and *Xyris baldwiniana.*

Euphorbia inundata is nearly restricted to Florida, where it occurs in the Jacksonville area, along the west coast of the peninsula and in the panhandle (Michael Huft, pers. comm.). It is perhaps most frequent in the Apalachicola lowlands from Wakulla to Bay counties, Florida. The nearest records to Mississippi are from Baldwin County, Alabama. The only other specimens of *E. inundata* outside of Florida are from Charlton and Ware counties, Georgia (Michael Huft, pers. comm.). It occurred with 10% frequency in sample plots on the Rains (Typic Paleaquults) soil series in Mississippi (Norquist 1984). Kral (1983) contrasts it with *E. telephoides* Chapm., a local Apalachicola endemic, and notes that *E. inundata* is usually found in moist to wet pine flatwoods savannas and borders of *Hypericum* dominated ponds. The author has noted *E. inundata* to be fairly frequent in wetland longleaf pine savannas in Liberty and Franklin counties, Florida; however, it is considered rare in the Pensacola region (Wilhelm 1984).

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REFUTATION OF RECENT CREATIONS OF MICROSPECIES AND HYBRID TAXA IN ARGENTINIAN *SOLANUM* (SECT. *PETOTA*)

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ABSTRACT

Arguments are presented against taxonomic splitting within *Solanum* from Argentina.

In recent years, we have been confronted with the splitting of well established taxonomic units of Argentinian wild potatoes and the proliferation of so-called "*spec. nov.*" of hybridogen origin. This deplorable tendency has created further problems for the understanding of the speciation of *Solanum*, a genus which traditionally suffers "*per se*" evolutionary and nomenclature problems.

When working with wild potatoes, one should always bear in mind the biological fact that the majority of diploid tuber bearing species are necessarily outbreeders. Consequently, their sexually produced offspring are not identical, but show (more or less) morphological and physiological segregation, which in extreme cases may simulate speciation. Their self incompatibility is based on a rather simple S-allele scheme (oppositional factors of multiple genes, at the same chromosome locus) which inhibits self fertilization. This important fact should never be overlooked by wild potatoes collectors and should be borne in mind by taxonomists in their zeal to immortalize their names in the description of new species. Unfortunately, this problem arose recently in Argentina. Members of several series of tuber bearing *Solanum*, such as *Acaulia, Cuneoalata, Megistacroloba* and *Tuberosa* were involved in an undue "name creation." We hope that those procedures may be discontinued. With regard to this, we may call attention to some recent publications (Okada & Hawkes 1978; Okada & Clausen 1982; Okada & Clausen 1985).

In sect. *Petota*, there is a "two way system of propagation:" sexual reproduction and vegetative clonal proliferation. To a certain degree, these have opposing effects on the frequency of genomic variability. Whereas sexual reproduction encourages a limited genetic segregation and diversity of given wild

potato species, asexual reproduction has a more conservative effect. With the former process, self sown seedlings may cause a continuous slight segregation inside the offspring generation, apparently leading to "microspecies," while the latter process of asexual-clonal reproduction allows survival of a chain of milieu adapted hybrid plants and many nothomorphic forms. This was already explained by Brücher in 1953 (the first case for Argentina).

Even genetically infertile *Petota* hybrids, or sterile introgression biotypes can maintain, by asexual reproduction, their identity for a long time, perhaps for ages.

Of course, between segregations and hybrids of this sort, neither can claim higher taxonomic status, nor do they deserve–in the light of a modern biological species concept (Löve 1964)–any botanical name. Hawkes f.e. was quite right when he once expressed: ". . . If these hybrids are to be named at all, they should be considered merely as nothomorphic forms of one species" (1963 p. 155). After having rejected his earlier, now outdated species concept, Hawkes wrote recently (1989 p. 58): ". . .in general the wildpotato species should be regarded as larger units that contain a wide range of genetic diversity. . .Such concept made it inadvisable, if not impossible, to divide potato species into the conventional infraspecific categories of varieties and forms." Similar thoughts have been repeatedly expressed by other solanologists (Correll 1962; Danert 1962; Dodds 1965; Ochoa 1984).

Therefore, we wonder why there exists such a wide gap between good theories and objectionable practice related to Argentinian wild potatoes.

PART I

a) Hybrid: *Solanum rechei* Hawkes & Hjerting

This "species" has a rather curious history, which began 60 years ago when the botanist Dr. Castellanos collected, in a farmer's settlement (Guanchín Viejo) situated in the semiarid Dept. Chilecito (Prov. La Rioja), an apparent wild potato (now included in the herbarium of the Museum B. Rivadavia, BA, as number 28/345 BA). The locality, at 29° S, 67° 38′ W, is easily accessible by a side road, 10 km from the town of Chilecito. The plant was claimed by Hawkes & Hjerting (1963) to be a new species. It received the binomial *Solanum rechei*, so called in attention to a friend of the latter author, who was at that time a merchant in Tucumán.

The short species diagnosis (1963 p. 146) claims a close phylogenetic affinity to *Solanum maglia*, a true species of long standing, which grows on the Pacific coast of the Chilean Republic.

The authors considerably underestimated the geographic distance (700 km) between the "*loci classici*" of the two epithets. Possibly, the similarity of names, Chile-Chilecito (which means little Chile) interfered subconsciously in

the minds of the foreigners who created this new species and committed the incredible gaffe of declaring *Solanum rechei* as the ancestral form of *Solanum maglia*. a species which lives on the Pacific coast, in Chile. separated from the former by the high Cordillera.

The term *S. rechei* has been created under the erroneous assumption of representing another endemic species of the Sierra Famatina (*l.c.* Brücher 1959; 1965), a very extended mountain chain of difficult access, with a maximum elevation of 6200 m.

Furthermore, the statement in the description that indicates that *S. rechei* occurs on several distant places of dry valleys in the province of La Rioja is not true. The truth, as we found out during several collecting trips to La Rioja, is that the so called *S. rechei* has a narrowly restricted manmade habitat in orchards of irrigated agricultural farms, called Guanchín Viejo, Las Tablas, Trapiche and a picnic place on the local automobile road from Chilecito to Mina de Oro. Our checking disproved completely, the pretention of the foreigners to have discovered a new species of *Solanum*. The results of several days inspection of the original locality and a comprehensive plant collection of more than 100 samples (available at our private herbarium in Mendoza), indicate that these "papas malezas" (= weed potatoes), as the local people quite correctly defined them, are the remainders of an earlier hybridization between *Solanum microdontum* (*sensu lat.*) and *Solanum kurtzianum*, two well known wild potatoes.

Although this has been already published in two short notices in German in 1969 and 1974, the authors of *Solanum rechei* did not eliminate their erroneous epithet, while they partially admitted their error and recognized the poor taxonomic value of this name in their book on Argentine wild potatoes (Hawkes & Hjerting 1969). But the last publication on the subject (Okada & Hawkes 1979) restores the erroneous name with the statement "*Solanum rechei* Hawkes & Hjerting es una papa silvestre. . ."

To maintain a "holotype" of *S. rechei* is misleading because Nr. 28/345 at BA is a casually segregated individual from a huge hybrid swarm of uncounted different morphotypes. We discovered this when we collected at random, hundreds of plants in the orchards and at irrigation ditches of Guanchín Viejo. None of the plants matched the others. Neither should they be named "F_1 plants" (Hawkes) because there is no proof of how and when such hybrid F_n populations arose. Keeping in mind that these orchards have been kept under irrigation for hundreds of years. and are plowed and harvested each year, the tubers of these hybrids swarms of F_n origin have been mixed and diffused by repeated cleaning and weeding of the irrigation ditches.

The following table is a testimony to the heterogeneity of such "papas malezas." This is only an abbreviated extract from our findings which shall be presented "*in extenso*" on another occasion.

Publication of Part II follows in short.

Table 1

Nr. of Collection	Plant Height in cm	Length X Width of Terminal Leaflet in mm	Quantity of lat[2] lflts	int[3] lflts	Stem Wings	Flowers[1]
1400	32	60 X 45	2	4	yes	#
1401	36	75 X 30	3	4	no	&
1402	40	40 X 25	4	6	no	&
1403	45	45 X 30	3	10	no	&
1404	40	30 X 22	4	12	no	&
1405	30	40 X 20	4	4	no	&
1406	40	50 X 20	4	8	yes	&
1407	22	45 X 22	4	6	no	%
1408	28	60 X 30	2	3	no	#
1409	22	40 X 18	5	8	no	#
1410	60	44 X 20	3	6	no	#
1411	18	40 X 20	2	2	no	#
1412	30	45 X 35	3	2	yes	#
1413	38	60 X 40	2	2	yes	#
1414	100	130 X 45	2	0	yes	#
1415	50	70 X 28	3	3	yes	#
1416	38	90 X 55	1	0	no	#
1417	25	80 X 60	1	0	no	#
1418	20	60 X 40	1	0	no	#
1419	16	70 X 55	2	0	no	#
1420	80	65 X 40	3	7	yes	#
1421	120	85 X 60	3	5	yes	&
1422	90	70 X 45	3	5	no	#
1423	108	65 X 30	4	7	no	#
1424	110	65 X 25	4	6	yes	#
1425	95	70 X 30	3	4	yes	%
1426	90	60 X 35	3	4	yes	#
1427	98	70 X 40	4	8	yes	%
1428	80	80 X 40	3	5	yes	%
1429	100	110 X 450	2	4	yes	&
1430	120	95 X 335	3	4	yes	&
1431	100	90 X 35	4	8	yes	&
1432	110	65 X 25	4	5	yes	%

Table 1 (cont.)

Nr. of Collection	Plant Height in cm	Length X Width of Terminal Leaflet in mm	Quantity of lat[2] lflts	int[3] lflts	Stem Wings	Flowers[1]
1433	90	50 X 20	4	3	no	#
1434	100	70 X 30	3	8	yes	%
1435	110	60 X 30	4	11	yes	%
1436	120	55 X 25	3	7	yes	#
1437	120	70 X 35	4	12	yes	#
1438	60	60 X 35	3	5	no	#
1439	100	85 X 45	4	6	no	#
1440	90	70 X 30	4	3	yes	%
1441	120	65 X 25	4	7	yes	&
1442	22	70 X 30	3	3	yes	#
1443	28	45 X 25	2	0	yes	#
1444	25	40 X 18	2	0	yes	#
1445	70	90 X 35	2	0	yes	%
1446	80	100 X 40	2	7	no	#
1447	90	90 X 40	3	2	yes	&
1448	20	80 X 40	2	3	yes	#
1449	120	90 X 60	3	6	no	#
1450	100	100 X 60	2	3	no	#
1451	130	75 X 33	3	7	yes	#
1452	140	115 X 45	4	6	yes	#
1453	80	70 X 35	3	3	yes	#
1454	90	65 X 30	2	3	no	%
1455	28	55 X 25	3	4	yes	#
1456	120	95 X 45	4	6	yes	#
1457	100	100 X 55	3	5	yes	&
1458	110	90 X 45	3	9	yes	#
1459	130	90 X 35	3	4	yes	&
1460	110	90 X 50	2	6	no	#
1461	80	75 X 35	3	0	no	%
1462	70	75 X 45	3	3	no	#
1463	90	85 X 40	3	7	no	#
1464	100	110 X 55	3	6	no	#
1465	120	80 X 35	4	5	yes	#
1466	25	55 X 40	1	0	no	#
1467	12	50 X 30	1	0	no	#
1468	15	55 X 25	2	0	yes	#

Table 1 (cont.)

Nr. of Collection	Plant Height in cm	Length X Width of Terminal Leaflet in mm	Quantity of lat[2] lflts	int[3] lflts	Stem Wings	Flowers[1]
1469	20	75 X 50	1	2	no	#
1470	12	50 X 30	1	0	yes	#
1471	14	40 X 35	1	0	no	#
1472	20	40 X 30	3	0	yes	#
1473	30	60 X 35	2	1	yes	#
1474	20	60 X 45	2	0	yes	#
1475	12	55 X 35	1	0	yes	#
"Holotype" 345	–	70 X 30	3	1	yes	&

[1] & stands for present; % stands for aborted; # stands for absent.

[2] lateral.

[3] interject.

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GENERIC AFFINITIES AND TYPIFICATION OF ELEVEN SPECIES EXCLUDED FROM *SIPHONOGLOSSA* OERST. (ACANTHACEAE)

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ABSTRACT

The genus *Siphonoglossa* Oerst., as recently delimited, includes only ten taxa belonging to the typical section. This delimitation of *Siphonoglossa sensu stricto* is warranted because several misconceptions concerning the vegetative and pollen morphology of the genus have been disclosed. Of the taxa excluded from the genus, most may properly belong to the closely related genus *Justicia* L., while others do not belong to the same tribe as *Siphonoglossa* and *Justicia*.

KEY WORDS: *Siphonoglossa, Justicia*, Acanthaceae, pollen, typification, systematics.

The genus *Siphonoglossa*, previously comprising 25 species, has long been subject to erroneous concepts as to its proper delimitation. As such, it became an artificial assemblage of species having little affinity to each other or to the original concept of the genus as based on the generitype (Oersted 1854). Several of these species do not even belong together at the tribal (or subtribal) level. This was shown by Hilsenbeck (1983), who narrowed the concept of *Siphonoglossa* to ten taxa in seven species belonging to the strictly New World type section (see Henrickson & Hilsenbeck 1979). It is therefore necessary to exclude the remaining 15 taxa from the genus, and this study concerns the treatment of 11 of these. The purpose of this paper, then, is to present the generic and tribal affinities of the taxa erroneously classified in *Siphonoglossa* and to discuss their typification since some of the types were either destroyed or not designated. Additionally, it is felt that considerable nomenclatural and taxonomic confusion surrounding the genus will be significantly reduced by the following account.

Six of the species here excluded from *Siphonoglossa* are African in distribution and, though belonging to the same tribe and subtribe as *Siphonoglossa* (Justicieae Lindau, Justiciinae Bremekamp), clearly do not belong to *Siphonoglossa* as recently delimited. The six species have an equally 5 parted calyx and conspicuously appendaged anther sacs, among other characters, which

strongly ally them with *Justicia* and the taxa referred to *Siphonoglossa* section *Pentaloba* Hilsenbeck (in Henrickson & Hilsenbeck 1979). Because the four taxa of *Siphonoglossa* section *Pentaloba* [type, *S. pilosella* (Nees) Torrey] possess morphological, chemical and cytological characteristics of *Justicia* rather than *Siphonoglossa*, they are to be formally transferred to *Justicia* (Hilsenbeck 1983; 1989a) and will not be dealt with further here.

All of the above taxa were placed in *Siphonoglossa* under what I have termed the artificial "Torreyan concept" of the genus as discussed elsewhere (Hilsenbeck 1983; 1989a). In short, Torrey (1859) widened considerably the limits of *Siphonoglossa* (type, *S. ramosa* Oerst.) by transferring into the genus an American species known for years to European botanists as *Adhatoda dipteracantha* Nees (= *Monechma pilosella* Nees), calling it *S. pilosella*. To accommodate this species, Torrey had to enlarge Oersted's original concept of *Siphonoglossa* to include characters that traditionally define the genus *Justicia* (see Leonard 1958; Long 1970). The inclusion in *Siphonoglossa* of *S. pilosella*, and later the African species *S. tubulosa* (E. Meyer) Bentham & Hooker [= *Adhatoda tubulosa* (E. Meyer) Nees] by Bentham (in Bentham & Hooker 1886), set a precedent for other taxonomists, particularly Moore, to classify elements in the genus based primarily on direct comparisons with *S. pilosella* (not *S. ramosa*) as representative of the genus. For example, in his description of *S. rubra*, Moore (1906), employing the Torreyan concept of the genus, states, "This plant. . . found in Tropical Africa, is quite unlikely any of its American and South African congeners. The flower has been compared carefully with that of *S. pilosella* Torr., and found to agree with it in all essentials of generic nature."

Excluded also here are five New World species placed in *Siphonoglossa* by Lindau. All of these species were so classified based on Lindau's misconception of the pollen morphology of the group as discussed elsewhere (Hilsenbeck 1983; 1989b). These five species properly belong in the tribe Odontonemeae Lindau, not in Justicieae, or following Bremekamp's (1965) system, they would be placed in Justicieae, subtribe Odontoneminae. For example, on transferring *Carlowrightia pringlei* Robins. & Greenm. to *Siphonoglossa*, Lindau (1897) states that the species, "ist eine typische *Siphonoglossa* wie aus der Form der Corolla und dem Pollen (Spangenpollen) hervorgeht." Spangenpollen is pollen that is basically prolate and tricolporate and is generally characteristic of Odontoneminae. The taxa of Justiciinae, including *Siphonoglossa sensu stricto* (Hilsenbeck 1983), are characterized by pollen that Lindau (1894; 1895) termed Knötchenpollen. This latter type of pollen is most often bilateral and 2 porate.

Therefore, all 11 species here excluded from *Siphonoglossa* were placed in the genus either upon: 1) the very broad and artificial "Torreyan concept" and are, for the most part, thus referable to *Justicia* or, 2) a misconception of pollen morphology and as such belong to a different tribe (or subtribe) of

Acanthaceae. I will not make the generic transfer of any of these species at this time, because I feel that they should be accorded more detailed study prior to their formal inclusion within other genera. It is clear, however, that these 11 species do not belong to *Siphonoglossa* as based on the type, *S. ramosa*.

EXCLUDED SPECIES

Siphonoglossa gentianifolia Lindau, Bull. Herb. Boissier 2:370. 1905. TYPE: PARAGUAY: Gran Chaco prope Santa Elisa ad marginem silvarum, w/o date, *Hassler 2841* (HOLOTYPE: B, destroyed; Phototypes: GH!,NY!).

In the description of this taxon Lindau states, "pollinis granula, subglobosa, typica" in direct reference to this species having Spangenpollen which Lindau mistakenly believed typical for the genus. Judging from the description and type photographs, this species is very closely related to another of Lindau's "siphonoglossas," as he states, "Verwandt mit *S. sulcata* (Nees) Lindau, aber durch die grosseren und viel breiteren Blatter, die kurzeren Bluten und die breiteren Brakteen sofort zu unterscheiden." The proper generic disposition of this taxon, of which the only material I have seen are the photos, will be discussed under *S. sulcata.* I have been unable to locate other specimens of *Hassler 2841* on which to base a lectotype, and in the absence of other authentic material I cannot properly designate a neotype.

Siphonoglossa glabrescens Lindau, Bull. Herb. Boissier 2:546. 1894. TYPE: MÉXICO, Oaxaca: distr. Tlacolula, prope Zoquitlan, Jun 1888, *Seler 76* (HOLOTYPE: B, destroyed; Phototypes: GH!,MICH!,NY!).

That this species is not a *Siphonoglossa* is plainly evident. The pollen was described by Lindau as "pollinis granula typica" again in allusion to its prolate, tricolporate nature (i.e., Spangenpollen). From the description and the photo of the type, it is clear that this taxon is in reality *Anisacanthus quadrifidus* (Vahl) Nees. Among other features, the species has a red corolla, the morphology of which is that of *Anisacanthus*, and conspicuously exfoliating bark also characteristic of that genus.

Siphonoglossa (?) *linifolia* (Lindau) C.B. Clarke, *in* W.T. Thiselton-Dyer, ed., *Flora Capensis* vol. 5, sect. 1:75. 1912. *Aulojusticia linifolia* Lindau, Bot. Jahrb. Syst. 24:325. 1898. LECTOTYPE (here chosen): SOUTH AFRICA: Kalahari Region, Transvaal, mountain sides of Saddleback Range, near Barberton, 22 Feb 1890, E. E. Galpin 825 (BOL!; Isolectotypes: NBG!,US!).

The holotype, Galpin 825 at Berlin, was destroyed. Therefore, Galpin 825 at BOL, an isotype, is designated as lectotype. The only vague resemblance that this South African species bears to *Siphonoglossa* is a very long corolla tube. The calyx is equally 5 parted, the anthers are conspicuously appendaged, and in habit and characters of the fruit, this taxon is not congeneric with *Siphonoglossa*. In transferring this species to *Siphonoglossa*, Clarke placed a question mark between the generic and specific epithets and earlier states, "The question is greatly complicated by the arrival of a third South African species (*Aulojusticia linifolia*) which has the corolla of *Beleropone* (he must have meant *Beloperone*), not of *Siphonoglossa*." Even as widely as Lindau stretched the generic boundaries of *Siphonoglossa*, he did not place this species in it, instead erecting a new genus, *Aulojusticia*, to accommodate it. I am in favor of leaving this distinctive species in Lindau's monotypic genus until future study can perhaps better determine its generic affinities.

Siphonoglossa macleodiae S. Moore, *in* Macleod, *Chiefs & Cities Centr. Afr.* 304. 1912. TYPE: NIGERIA: N Nigeria, River Benue, Sep 1910, *P. A. Talbot s.n.* (HOLOTYPE: BM!; Isotype: MO!).

This species clearly belongs to *Justicia* subgenus *Eujusticia*, near sections *Adhatoda* and *Tyloglossa* of Lindau (1895), because of its flowers borne solitary and sessile in the leaf axils, equally 5 parted calyx, and spurred anther sacs. An illustration of the pollen is affixed to the holotype showing that this species has Knötchenpollen.

Siphonoglossa migeodii S. Moore, J. Bot. 67:271. 1929. TYPE: TANZANIA: Tanganyika Terr., w/o date, *F.W.H. Migeod 137* (HOLOTYPE: BM!).

From all appearances, the relationships of this species clearly lie with the other African elements which have been mistakenly included in *Siphonoglossa*. It may be that the only extant material of this species is that of the type collection and two paratypes (*Migeod 473*, BM) as I have not seen any other specimens of this taxon, even from the South African herbaria from which I borrowed material. As with *S. macleodiae*, the proper classification of this little known species should await further study directed primarily at these Old World taxa. It appears, however, that this species has affinities with *Aulojusticia linifolia* through its corolla, inflorescence and fruit morphology, as well as with *Justicia* in its 5 parted calyx and conspicuously spurred lower anther sac.

Siphonoglossa nummularia S. Moore, J. Bot. 18:40. 1880. TYPE: SOUTH AFRICA: "British Kaffraria," 1860, *T. Cooper 370* (HOLOTYPE: K!).

As noted above, Moore accepted, followed, and even expanded upon Torrey's artificial concept of the genus. Indeed, *S. nummularia* with its 5 parted

calyx and spurred lower anther sacs fits well within *Justicia*, not *Siphonoglossa*. Its most closely allied taxa appear to be the other South African "siphonoglossas" and section *Pentaloba* of *Siphonoglossa* which is currently being transferred to *Justicia* (Hilsenbeck 1989a).

> *Siphonoglossa peruviana* Lindau, Bot. Jahrb. Syst. 42:173. 1908. TYPE: PERÚ. Amazonas: Prov. Chachapoyas, östliche Talwand des Marañon über Balsas, w/o date, *A. Weberbauer 4269* (HOLOTYPE: B, destroyed; Phototypes: GH!,NY!).

As with the other taxa placed in *Siphonoglossa* by Lindau, this species has Spangenpollen and thus more properly belongs in Odontonemeae. The type material unfortunately has been destroyed and I cannot locate any other material of *Weberbauer 4269* with which to lectotypify this species. On initial inspection, it appears that *S. peruviana* may belong in the genus *Yeatesia*, having a very similar overall inflorescence and corolla morphology to this genus (Hilsenbeck 1989c). From the original and rather detailed description of the fruit and seeds, and the type photos, however, this species undoubtedly belongs in *Tetramerium* and Daniel (1986) has recently and correctly made the formal transfer.

> *Siphonoglossa pringlei* (Robins. & Greenm.) Lindau, Bull. Herb. Boissier 5:622. 1897. BASIONYM: *Carlowrightia* (?) *pringlei* Robins. & Greenm., Proc. Amer. Acad. Arts 32:40. 1896. TYPE: MÉXICO. Oaxaca: dry slopes Tomellin Cañon, 30 Nov 1895, *C.G. Pringle 6261* (HOLOTYPE: GH!; Isotype: CAS!).

This species has Spangenpollen and as such should be in the Odontonemeae, well removed from *Siphonoglossa*. In his monographic treatment of *Carlowrightia*, Daniel (1980) included this species under *Carlowrightia* where it correctly belongs.

> *Siphonoglossa rubra* S. Moore, J. Bot. 44:88. 1906. TYPE: UGANDA: Entebbe, w/o date, *Bagshawe 750* (BM).

Although Moore states that the type of this species is at BM, I did not receive any material of it in a loan from BM that contained the holotypes of two other African species placed by Moore in *Siphonoglossa*. I have not seen, nor do I know the location of any material of *Bagshawe 750* and have, therefore, been unable to properly lectotypify the species. I have, however, examined several other specimens of this seemingly polytypic, red flowered species. As stated above, Moore carefully compared the flowers of *S. rubra* and *S. pilosella* and found them to agree "in all essentials of generic nature." It is indeed true that these two taxa have a similar "flower" morphology, including androecium structure, an equally 5 parted calyx and other features in common. However,

in characters of the inflorescence, corolla, fruit and seed, *S. rubra* more closely resembles the widespread tropical African and Asian *Rhinacanthus nasutus* (L.) Lindau (= *R. communis* Nees). Though clearly not a *Siphonoglossa*, it perhaps does belong in *Rhinacanthus*, but as with the other African taxa herein discussed, its proper generic disposition should await further investigation.

Siphonoglossa sulcata (Nees) Lindau, Bot. Jahrb. Syst. 48:19. 1894. BASIONYM: *Jacobinia sulcata* Nees *in* DC., Prodr. 11:333. 1847. *Dianthera sulcata* (Nees) Griseb., Goett. Abh. 19:224. TYPE: ARGENTINA: Río Parana, w/o date, *Tweedie s.n.* (HOLOTYPE: K!).

This species is clearly not related to *Siphonoglossa* but instead has a very close affinity to the genus *Yeatesia* Small, tribe Odontonemeae, of the southern United States and adjacent northeastern México (Hilsenbeck 1983; 1986c). This species and *S. gentianifolia* possess Spangenpollen and also have inflorescences, corollas, androecia, fruits and seeds characteristic of *Yeatesia* and the Old World genus *Ecbolium* and are clearly most closely related to (besides each other) these two genera. The proper generic classification of these species is under active consideration.

Siphonoglossa tubulosa (Nees) Bentham & Hooker, Gen. Pl. 2:1110. 1886. This combination should properly be *S. tubulosa* (E. Meyer) Bentham & Hooker, but is cited here as listed by Bentham & Hooker (1886). BASIONYM: *Justicia tubulosa* E. Meyer *in* Drege, Zwei Pflanzengeogr. Documente 150,196. 1837. *Rhinacanthus tubulosus* (E. Meyer) Presl, Bot. Bemerk. 95. 1843. *Adhatoda tubulosa* (E. Meyer) Nees *in* DC., Prodr. 11:392. 1847. LECTOTYPE (here chosen): SOUTH AFRICA: Pondoland between St. Johns River and Umtsikaba River, 1837, *S.F. Drege s.n.* (K!; Isolectotypes: K!,MO!).

Justicia suffruticosa E. Meyer *in* Drege, Zwei Pflanzengeogr. Documente 153, 196. 1837.

Justicia prostrata Schlechtend. *ex* Nees *in* DC., Prodr. 11:390. 1847.

Gendarussa leptantha Nees, Linnaea 15:372. 1841. *Adhatoda leptantha* (Nees) Nees *in* DC., Prodr. 11:392. 1847. *Justicia leptantha* (Nees) Lindau *in* Engl. & Prantl, Naturl. Pflanzenfam. 4, 3b:349. 1895.

Of the three sheets of this collection at K, two have been annotated by Nees von Esenbeck, and of these two, the most complete specimen has been chosen as lectotype. I think that this species most properly belongs in *Justicia* or in *Adhatoda*, if one accepts the latter genus. It is notable that Nees (1847) placed this species in the same genus with *Adhatoda hyssopifolia* (L.) Nees (= *Justicia hyssopifolia* L.) and *Adhatoda dipteracantha* Nees [= *Siphonoglossa pilosella* (Nees) Torrey]. *Justicia hyssopifolia* is one of the two proposed lectotypes of the genus *Justicia* (Stearn 1971). This points clearly to the close

affinity of *S. pilosella*, not only with *Justicia* (and *Adhatoda*), but with the African taxa improperly placed in *Siphonoglossa*. An instructive commentary concerning the generic status of this species was that of Clarke (1912). He states, "*S. tubulosa* was removed from *Justicia* to the American genus *Siphonoglossa* by Bentham (Benth. *et* Hooker, *f.* Gen. Pl. ii. 1110). S. Moore added *S. nummularia* which is beyond question congeneric with *S. tubulosa*. Baillon (Hist. de Plantes, X. 441) records *S. tubulosa* under *Siphonoglossa* but does not appear to have examined or considered it. Lindau (in Engl. & Prantl., Pflanzenfam. IV. 3B, 338) says that these two species can scarcely be referred to *Siphonoglossa* and (*l.c.* p. 349) records *S. tubulosa* (under a different name) as a true *Justicia*." I agree with Clarke that *S. tubulosa* and *S. nummularia* are closely related, if not congeneric. I also agree with Lindau that these taxa should be excluded from *Siphonoglossa* (but for a different reason) and placed in *Justicia*, the former as *J. tubulosa* E. Meyer.

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CHANGE OF NAME IN A TUBER BEARING *SOLANUM*

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ABSTRACT

Solanum chillonanum Ochoa is proposed as an avowed substitute for *Solanum tenellum* Ochoa, which is a later homonym of *S. tenellum Bitter*.

KEY WORDS: Solanaceae, *Solanum*, nomenclature.

Since the specific epithet *tenellum* that I recently published was already in use in *Solanum* by Bitter, I wish to replace my later homonym with the following combination.

Solanum chillonanum Ochoa, *nom. nov.* = *Solanum tenellum* Ochoa, Phytologia 63:455. 1987. (non *S. tenellum* Bitter, Repert. Spec. Nov. Regni Veg. 11:219. 1912).

CORRECTIONS OF NEW COMBINATIONS IN *EUPHORBIA*

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ABSTRACT

In order to technically validate two nomenclatural combinations made in a previous paper (Oudejans 1989), two corrections are made.

KEY WORDS: Euphorbiaceae, *Euphorbia*, nomenclature.

Due to a typist's error in the editor's office, a new combination and a new name were incorrectly listed in a previous paper (Oudejans 1989). In order to validate these names, they are repeated here. The editor apologizes to Dr. Oudejans for these errors and would urge all authors, whenever possible, to send manuscripts on computer diskettes.

Euphorbia rockii Forbes var. **grandifolia** (Hillebrand) Oudejans, comb. nov. BASIONYM: *E. clusiifolia* var. *grandifolia* W. Hillebrand, Fl. Hawaiian Isl. 395 (as 'clusiaefolia). 1888.

Euphorbia smallii Oudejans, nom. nov., pro *Chamaesyce pinetorum* J.K. Small, Bull. N.Y. Bot. Gard. 3:429-430. 1906. TYPE: UNITED STATES. [Florida:] between Cutler and Camp Longview *Small & Carter 836*. The name *pinetorum* is not available in the genus *Euphorbia*.

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Oudejans, R.C.H.M. 1989. New names and new combinations in the genus *Euphorbia* L. (Euphorbiaceae). Phytologia 67(1):43-49.

NEW TAXA AND NOMENCLATURAL COMBINATIONS IN
SENECIO IN MÉXICO AND THE UNITED STATES

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ABSTRACT

The following new species and new variety are described: **S. billieturneri** T.M. Barkley, **S. lasiocaulon** T.M. Barkley, **S. porphyresthes** T.M. Barkley, **S. pseudopicridis** T.M. Barkley, **S. scalaris** var. **carmenensis** C.C. Freeman (all from México); and **S. spellenbergii** T.M. Barkley (from New Mexico, U.S.A.). The following new combinations are proposed: **S. flaccidus** var. **durangensis** (Greenm.) T.M. Barkley, **S. hintonii** (H. Robins. & Brettell) J. Pruski & T.M. Barkley, **S. multidentatus** var. **huachucanus** T.M. Barkley and **S. scalaris** var. **parrasianus** (Greenm.) C.C. Freeman.

KEY WORDS: *Senecio*, Asteraceae, México, United States, systematics.

Studies in *Senecio* in North America have led to the recognition of four new species from México and one from the United States, plus the need for four nomenclatural adjustments. They are presented in this paper.

Craig C. Freeman has kindly allowed me to present here a new variety and a new combination under *Senecio scalaris* in advance of the publication of his revision of the Aureoid species of *Senecio* in México. Thus, the names will be available for the forthcoming work on the Asteraceae of México by B.L. Turner & Guy Nesom. Author citation for the new variety and the new combination may be simply "C.C. Freeman" (instead of "Freeman *in* Barkley"), *fide* art. 46.2 of the *International Code of Botanical Nomenclature* (1988). Likewise, the new combination proposed below by J. Pruski & T.M. Barkley may be cited simply by those two authors.

The new species described here are known to me only from the collections that are cited. The habitat and distributional information is that of the specimen labels from the various collections.

Senecio flaccidus var. **durangensis** (Greenm.) T.M. Barkley, *comb. et stat. nov.* BASIONYM: *S. durangensis* Greenm., Publ. Field Columbian Mus., Bot. Ser. 2:275. 1907.

S. ctenophyllus Greenm., Proc. Amer. Acad. Arts 43:20. 1907. (not *S. cteno-phyllus* Phil.).

Senecio hintonii (H. Robins. & Brettell) J. Pruski & T.M. Barkley, *comb. nov.* BASIONYM: *Roldana hintonii* H. Robins. & Brettell, Phytologia 27:420. 1974.

John F. Pruski of The New York Botanical Garden noted the need for this combination on some herbarium annotation labels several years ago. I agree with the utility of the transfer to *Senecio* and it is my pleasure to join John Pruski in presenting this combination.

Senecio multidentatus var. **huachucanus** (A. Gray) T.M. Barkley, *comb. et stat. nov.* BASIONYM: *S. huachucanus* A. Gray, Proc. Amer. Acad. Arts 19:54. 1883.

Senecio scalaris var. **parrasianus** (Greenm.) C.C. Freeman, *comb. et stat. nov.* BASIONYM: *S. parrasianus* Greenm., Ann. Missouri Bot. Gard. 4:20. 1917.

Senecio billieturneri T.M. Barkley, *sp. nov.* Figure 1. TYPE: MÉXICO. Durango: Lecheria, about 6 miles W of El Salto, along road to Mazatlan, along banks and in shallow water of stream, elev ca 8500 ft, perennial herb with ray and disk florets both yellow, (no date), *Howard Scott Gentry 10610* (HOLOTYPE: MICH; Isotype: MEXU).

> *Senecio multidentato* Sch.-Bip. similis, sed capitulis magnis (1-) 4-10, disco 12-20 mm diametro et involucri bracteis 9-12 mm longis, necnon foliis caulinis medianis ac superioribus caulem circumdantibus semiamplexicaulibus, ulteris ecologia semiaquatica diversus.

Coarse, soft stemmed herb to 6+ dm tall. Herbage mostly glabrate at flowering time, but with scattered short hairs on the upper stem, the pedicels and base of the heads; variously dense pubescent on the involucral bracts. Stems arising singly or 2-3 loosely clustered from an elongate rhizome with abundant fleshy fibrous roots; the roots unbranched or with a few thin, lateral branches. Basal leaves and those of the lower 1/2 of the stem of about equal size and not disposed in a clearly defined basal cluster, upper leaves few and somewhat reduced; the well developed leaves linear-lanceolate to narrowly lanceolate, the blade 8-15 cm long and 1-2.5 cm wide, tapering to a winged petiole about as long as the blade or shorter, the middle and upper cauline leaves becoming sessile and with the bases encircling and weakly sheathing the stem, but not at all auriculate clasping, margins subentire or obscurely wavy, with a few, minute, callose denticles. Inflorescence a corymbiform cyme of (1-)4-10 heads; the ultimate branches of the inflorescence (pedicels) 3-7(-10) cm long, with 3-5 subulate bracts 5-7 mm long, equidistantly placed along the length

of the pedicel. Heads cylindrical to campanulate at maturity, the disk 12-20 mm across; principal involucral bracts ca 21, triangular-lanceolate, 9-11+ mm long, the central rib prominent, greenish and ± permanently short pubescent, the margins scarious-stramineous and glabrous, the tip weakly attenuate and darkened, but without a distinctive blackish spot; calyculate bracts mostly 5-8, greenish, subulate, (3-)5-9 mm long; receptacle flat or low hemispheric, sometimes infested with insect larvae, naked or with low, erose ridges among the achenes; ray florets ca 13, pistillate and apparently fertile, the ligule bright yellow, 10-15+ mm long in dried specimens; disk florets numerous, often more than 50, bisexual and apparently fertile, corolla yellow, 7-8 mm long, the throat separating the tube from the limb ca 2/5 the distance up from the base, the limb narrowly tulip shaped and flared upward to 5 small triangular lobes, ca 1 mm long or less. Achenes 5-6 mm long (immature), angled, glabrous; pappus a single series of grayish white, minutely barbellate, capillary bristles, 3-5+ mm long but of uneven lengths.

Paratypes: (All from MÉXICO. Durango: along or near Mexican highway 40, west of the city of Durango): Alrededores del Mil Diez, 2 kms al N de El Salto, Mpio. de El Salto, alt 2200 m, Junio 27, 1982, *R. Hernández M. 7414 y P. Tenorio* (KSC); wet meadow in *Pinus lutea* and *Pinus durangensis* forest, 10 miles west of El Salto on Route 40, elev 9000 feet, July 16, 1964, *Miles & Wilma Johnson 1859 & 1861* (both WIS); 10 miles W of El Salto along Mexican Rte 40, pastured pine woodland, 27 June 1974, *Marvin L. Roberts & David Keil 10319* (F,OS); 4.5 km al SW de El Salto, brecha El Salto-Pueblo Nuevo, Mpio. de El Salto, alt 2100 m, 3 de Julio de 1982, *P. Tenorio L. 808 y C. Romero de T.* (KSC); Las Adjuntas, Mpio. de El Salto, alt 2000 m, 5 de Julio de 1982, *P. Tenorio L. 829 y C. Romero de T.* (KSC).

Senecio billieturneri is referable to Group 11c, Triangulares, in the scheme of Barkley (1985). It is similar to *S. multidentatus* Sch.-Bip. and the closely related *S. huachucanus* A. Gray (which is transferred in this paper to varietal status within *S. multidentatus*). It differs from them in having (1-)4-10 notably large heads, the middle and upper cauline leaf bases encircling and weakly sheathing the stem, and in a semi-aquatic habitat, or at least the ability to grow as a facultative aquatic. The species is further noteworthy in its rather long achenes in comparison to the length of the corolla and the pappus of the disk florets.

Two of the paratypes noted above, *Miles & Wilma Johnson 1859 & 1861*, are distinctive in being monocephalous and in having few and reduced cauline leaves. Otherwise, they cannot be excluded from *S. billieturneri* as it is conceived here.

It is a pleasure to name this species for Dr. B.L. Turner of the University of Texas, who has made notable contributions to the knowledge of the botany of North America, and who has been an inspiration for two generations of botanists.

Senecio lasiocaulon T.M. Barkley, *sp. nov.* Figure 2. TYPE: MÉXICO.
Durango: Fourteen miles west of Cd. Durango (Durango to El Salto
highway), edge of limestone out-cropping dropping into arroyo south
of highway, grasslands, with very sparse growth of oak scrub, eleva-
tion 2000-2200 m, frequent, flowers bright yellow, June 1950, *James H.
Maysilles 7032* (HOLOTYPE: NY; Isotypes: MEXU,MICH).

Senecio picridis Schauer simulans, sed foliis semper lanato-
tomentosis, superioribus qual mediana minoribus, hic ultra 15 cm
longis, necnon capitulescentia laxa diffusa, capitulorum numero
(-15) diversus.

Subshrub 2-5 dm tall. Herbage white, closely felted lanate-tomentose
throughout, but upper side of leaves somewhat grayish and unevenly glabres-
cent in age. Stems strict, branching only in upper 1/4, distinctly ligneous be-
low but herbaceous upward, arising singly or loosely clustered from a ligneous,
subrhizomatous caudex, with numerous branching, fibrous roots. Leaves about
evenly distributed along the stem, the lowermost withering early, those of
the upper 1/4 of the stem reduced in size; well developed mid-cauline leaves
oblanceolate to linear-oblanceolate, tapering to a weakly distinct, winged peti-
ole, 7-12(-15) cm long and (0.5-)1-1.5 cm wide overall, distinctly auriculate
clasping at the base. Inflorescence a weakly compacted to loose corymbiform
to subpaniculiform cyme of ca 7-15 heads, the ultimate branches of the inflores-
cence (pedicels) 2-3+ cm long. Heads subcylindrical to narrowly campanulate,
the disk 5-7 mm across; principal involucral bracts ca 13(-21), linear lanceolate
to lanceolate, (4-)5-6 mm long, densely and permanently close tomentose along
the median ridge, margins glabrous and stramineous, the apex minutely erose
fimbriate and faintly to prominently darkened; calyculate bracts ca 5 or fewer,
sometimes absent, linear subulate, less than 2 mm long, sometimes obscurely
anthocyanic; receptacle ca 4 mm across, flat or low hemispheric, naked except
for low, erose ridges among the achenes; ray florets ca 8(-13?), pistillate and
apparently fertile, corolla yellow, the tube ca 4 mm long, the ligule 5+ mm
long in dried specimens; disk florets (15-)20-25, bisexual and apparently fertile,
corolla yellow, ca 5-6 mm long overall, the lower 1/4 narrowly cylindrical, the
upper 3/4 conically expanded and terminating in 5 short, triangular lobes less
than 1 mm long. Achenes (immature) ca 2.5 mm long, angled, minutely hirtel-
lous on the angles; pappus of abundant, minutely barbellate, white hyaline,
capillary bristles in a single series, 5-7 mm long, but of uneven lengths.

Paratypes: (All from MÉXICO. Durango: along or near Mexican highway
40 west of the city of Durango). Among boulders at base of cliffs in Mimbres
Canyon, 40 miles W of Durango, July 24, 1958, *D.S. Correll & I.M. Johnston
20139* (NY); weedy meadow and roadcut in pine forest belt, 7 km NE of El
Salto, alt ca 2800 m, July 21, 1969, *B. & C. Marcks 1238* (DAV,WIS); 34 miles
west of Cd. Durango, June 23, 1950, *J.H. Maysilles 7072* (MICH); about 5

Figure 1. *Senecio billieturneri* - holotype.

Figure 2. *Senecio lasiocaulon* - holotype.

miles north of railroad at Coyotes (45 airline miles west of Cd. Durango), June 28, 1950, *J.H. Maysilles 7123* (MICH,MEXU).

Senecio lasiocaulon is referable to Group 10c, Fruticosi, *s. str.* in the scheme of Barkley (1985). It is similar to *S. picridis* Schauer, a species chiefly of the eastern Trans-Mexican Volcanic Belt and the Sierra Madre Oriental, but it differs in having permanently lanate-tomentose herbage, upper leaves distinctly smaller than the middle cauline leaves, well developed leaves that are regularly more than 8 cm long, and a loose, open inflorescence of fewer than 15 heads.

The specific epithet "lasiocaulon," is derived from the Greek roots "lasi-," shaggy-wooly, and "caulos," stem or stalk, as an allusion to the conspicuous pubescence of the herbage.

Senecio porphyresthes T.M. Barkley, *sp. nov.* Figure 3. TYPE: MÉXICO. Tamaulipas: On mountain top 7 km SW of Miquihuana in forest of large pines, forest floor of low vegetation, elev 3430 m, (23° 40′ N, 99° 45′ W), Aug 5, 1941, *L.R. Stanford, L. Rutherford & R.D. Northcraft 679* (HOLOTYPE: NY; Isotypes: GH,MO).

Senecio gerberaefolio Sch.-Bip. similis, sed ab eo notulis sequentibus diversus: capitulum solitarium et minus, disco 12-20 mm diametro et involucri bracteis 12-14 mm longis; folia subduplo minora, 4-10(-12) X 1-1.5 cm; caules tenues nec robusti.

Subscapose herb 10-15 cm tall. Herbage closely lanate-tomentose, but becoming loosely tomentose with long, arachnoid hairs toward the base or unevenly glabrate; upper side of the leaves glabrescent, lower side closely and permanently short felted lanate. Stem simple, arising singly in a cluster of basal leaves from the end of a rhizome; uppermost 1/4 of the stem with 2-5 linear bracts 5-15 mm long. Rhizome creeping, simple, nearly 1 cm in diameter, covered by the exfoliating bases of old leaves and producing numerous fibrous branching roots. Leaves all basal or nearly so, narrowly oblanceolate to subspatulate, the blade tapering to the winged petiole, 4-10(-12) cm long overall and 1-1.5 cm wide, somewhat coriaceous, the margin denticulate with callose denticles, weakly revolute to flat. Head single, broadly campanulate to obconic, the disk 12-20 mm across; principal involucral bracts ca 16-20, all of equal length but disposed in an inner and an outer series, 12-14 mm long and to 2+ mm wide, linear-lanceolate, felted lanate-tomentose on the outer side, the margins and tip prominently and permanently magenta or pinkish-purple; calyculate bracts few, reduced and without the distinctively colored margins and apex; ray florets 12 (or more?) pistillate and apparently fertile, the corolla tube ca 6 mm long, the throat with a prominent thickened collar; the ligule sharply defined at the throat, bright yellow, 10+ mm long and to 5 mm wide; disk florets bisexual and apparently fertile, the corolla ca 8 mm long, tapering upward, the throat indistinct, the limb gradually flared and terminating in 5

small, triangular lobes 0.7-0.9 mm long. Achenes 2 mm long (immature), with appressed, flat, hyaline hairs (which presumably persist); pappus of both ray and disk florets of abundant, white, minutely barbellate capillary hairs that are nearly as long as the disk corollas.

Senecio porphyresthes is referable to Group 11e, Lugentes, in the scheme of Barkley (1985). It is similar to *S. gerberaefolius* Sch.-Bip., a species of the higher peaks in the eastern Trans-Mexican Volcanic Belt, but differs in having single and somewhat smaller heads, leaves only about half the size, and subscapose stems that are notably thinner. This new species is known to me by only three specimens from a single collection, but the aspect and combination of characters suggest that it is distinct. The purple-magenta color of the margins and tips of the involucral bracts is most prominent in the isotype in GH; the holotype in NY has the color somewhat faded.

Senecio gerberaefolius has a chromosome number of $n = 30$ (vouchered on specimens of *John H. Beaman 1948*, México. Ixtaccihuatl, GH,MEXU,UC, WIS), a number associated with cacalioid affinities and a distinctive suite of microcharacters (cf Barkley 1985). To date, cacalioid characters have not been specifically identified for *S. gerberaefolius*, but it will be interesting to learn if *S. porphyresthes* has $n = 30$ and/or cacalioid microcharacters. The disposition of the principal involucral bracts in an identifiable inner and outer series, as they occur in *S. porphyresthes* is often present with cacalioids.

The specific epithet, "porphyresthes," is derived from the Greek "porphyr," purple, and "esthes," garment, as an allusion to the conspicuous coloring of the involucre.

Senecio pseudopicridis T.M. Barkley, *sp. nov.* Figure 4. TYPE: MÉXICO. San Luis Potosí: Cerro Grande, 8 km al NW de Guadalcázar, ladera granítica con vegetación de encinar, alt 2000 m, 25-IX-1955, *Rzedowski 208* (HOLOTYPE: GH; Isotype: MICH).

> *Senecio picridis* Schauer simulans, sed semper herbaceus, et foliis primariis oblanceolatis, praeter denticulas callosas minutas integris, lamina in petiolum distinctum decurrenti diversus.

Subligneous herb 2-4+ dm tall. Herbage unevenly arachnoid-tomentose, especially upward and among the heads in the inflorescence, irregularly glabrate in age, the leaves persistently grayish lanate tomentose on the underside. Stem thin, stiff, branching upward from near the base, arising singly or 2-4 from a weakly ligneous taproot. Leaves prominently developed along the lower 2/3 of the stem; upper leaves few and somewhat reduced. Principal mid-cauline leaves oblanceolate to narrowly oblanceolate, 6-8(-10) cm long overall and 1-1.5+ cm wide, tapering to a narrow, weakly winged petiole, margins subentire, with minute callose denticles, or sometimes with 1-3 prominent, rounded teeth

HERBARIUM OF KANSAS STATE UNIVERSITY
MANHATTAN, KANSAS
Senecio porphyresthes T.M. Barkley
HOLOTYPE

Annotated by J. M. Barkley   1980
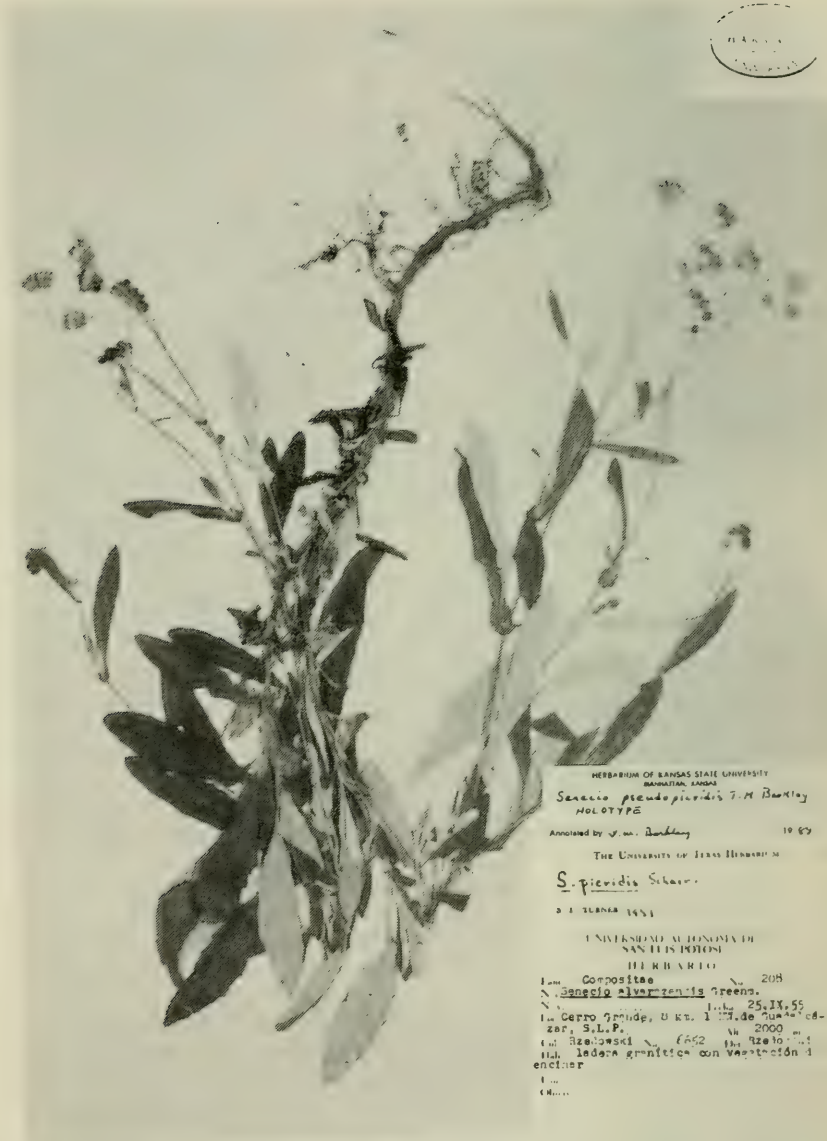
STATE OF WASHINGTON
PLANTS OF MEXICO

Senecio sp.   (fide I.L. Johnston)

On mountain top 7 kilo. S. W. of Aljojubani in
forest of large pines; forest floor of low
vegetation.

Coll. by L. R. Stanford   3430
      L. L. Retherford 23 42   97 45   August 5, 1941
      R. D. Northcroft   No. 679

Figure 3. *Senecio porphyresthes* - holotype.

Figure 4. *Senecio pseudopicridis* - holotype.

on the lower (proximal) 1/2 of the blade, the base expanded and auriculate-clasping, but sometimes inconspicuously so. Inflorescence a loose, corymbiform cyme of (5-)6-12+ heads terminating each main branch, the ultimate branches of the inflorescence (pedicels) 2-5 cm long, with 1-3 minute, linear bractlets equidistantly placed along the length of the pedicel. Heads cylindrical or slightly campanulate at maturity, the disk 5-8 mm across; principal involucral bracts ca (13-)21, linear-lanceolate to weakly subulate, 6-7 mm long at maturity, glabrescent, but with a few, scattered, minute, thick hairs, and sometimes with some persisting arachnoid-villous hairs, apparently anthocyanic toward the tip when young, the apex with a minute, darkened tip and a small tuft of arachnoid hairs; calyculate bracts 4-8, linear, spreading, ca 2 mm long, the tip darkened and with a tuft of hairs; receptacle flat or low hemispheric, naked or nearly so; ray florets ca 8 or 13, pistillate and apparently fertile, the ligule bright yellow, 6-8+ mm long in dried specimens; disk florets numerous, ± 25-35, bisexual and apparently fertile, the corolla 7-8 mm long, the lower 2/5 tubular, the upper 3/5 conical and terminating in 5 small triangular lobes, ca 1 mm long or less. Achenes ca 3 mm long (immature), angled, evenly short pubescent with minute, grayish hairs; pappus a single series of white hyaline, minutely barbellate, capillary bristles, 6-8 mm long, but of uneven lengths.

Paratype: MÉXICO. Zacatecas: 16 (air) miles E of Concepción de Oro, on upper north side of Sierra de Astillero, ca 3 miles NE of Guadalupe Garceron, 1/2 mile N of summit, in open pinyon woodland, frequent perennial, flowers true yellow, elev 8200 ft, Sept 22, 1973 (near 24° 38′ N, 101° 08′ W), *James Henrickson 13345* (LL).

Senecio pseudopicridis is referable to Group 11c, Triangulares in the scheme of Barkley (1985). It is similar to *S. picridis* Schauer, a species chiefly of the eastern Trans-Mexican Volcanic Belt and the Sierra Madre Oriental. However, *S. pseudopicridis* is fundamentally herbaceous, its principal leaves are oblanceolate, the blade tapering to a well marked petiole, subentire or nearly so, except for the minute, callose denticles. Clearly, *S. pseudopicridis* approaches some specimens of *S. picridis*, but the combination of characters and the gross aspect define it as a distinct species. Further information may alter the concepts of these two entities.

The holotype and the paratype cited above both have leaf bases that are auriculate clasping, but the isotype (in MICH) has leaf bases that are scarcely expanded. However, the isotype is otherwise identical with the holotype and is evidently of the same collection, from the same population. It raises the interesting question of the stability of the character of auriculate clasping leaves. Herbarium studies indicate that other species that normally possess that trait, occasionally do have individuals with narrow based leaves. Experience with *Senecio* suggests that virtually no characters of taxonomic utility occur without occasional exceptions.

Senecio spellenbergii T.M. Barkley, *sp. nov.* Figure 5. TYPE: U.S.A. New Mexico: Harding Co., Hwy NM 120, 16 miles NE of Roy, ca 11 miles SE of Yates, S side of Carrizo Creek, on white caliche in prairie, milepost 91, only 2 seen in late flower, the rest past (and this was late spring); phyllaries of older heads becoming glabrate, dark maroon; heads rayless, dull yellowish; 1-6 rosettes in a patch; leaves convex above, concave or grooved beneath, May 29, 1983, *Richard Spellenberg 7073* (HOLOTYPE: NY; Isotypes: KSC,NMC,TEX).

Senecio werneriaefolium A. Gray simulans, sed tomento appresse coacto, foliis angustis arcte revolutis, capitulis eradiatis fere semper solitariis, necnon achaeniis hirtellis diversus.

Dwarf, scapose herb, 3-5+ cm tall. Herbage closely whitish tomentose, the leaves with vestiture tightly felted into a velamen-like covering that irregularly exfoliates in age, upper herbage subglabrescent. Stems arising singly or sometimes 2 from a tufted rosette of basal leaves; the rosettes single or 2-6 closely clustered, from a simple or branching, suberect or weakly creeping, coarse rhizome, 3-5 mm in diameter; principal roots fleshy fibrous, branch roots thin and thread like. Principal leaves all basal, coriaceous, linear, 10-15 mm long, strongly revolute and only 1-2 mm wide; cauline leaves reduced to 2-4(-5) linear-subulate bracteoles, 2-3 mm long. Head single (rarely 2) at the end of the stem, eradiate, the disk ca 10 mm across; principal involucral bracts ca 13, linear-lanceolate, acute, 6-8 mm long, purplish to deep maroon-purple along the wide midrib and toward the tip, margins wide and scarious-stramineous; calyculate bracts 1-4, linear-subulate, less than 4 mm long; receptacle low hemispheric, naked; ray florets absent; disk florets ca 20(+) in number, bisexual and apparently fertile; corolla yellow, ca 6 mm long, the throat ca 2/5 the distance upward from the base, the limb narrowly conical, terminating in 5 triangular lobes 0.5-0.7 mm long. Achenes cylindrical to weakly fusiform, ca 3 mm long, inconspicuously angled, hirtellous; pappus of abundant, white hyaline, minutely barbellate, capillary bristles 5+ mm long but of uneven lengths.

Paratypes: (From same locality as type collection, but with following data): On white, nearly barren, very calcareous knolls in shortgrass prairie, elev 5500 ft, July 2, 1981, *R. Spellenberg, R. Soreng & T. Fisher 6053* (KSC,NMC).

Senecio spellenbergii is assignable to the "Tomentosi" group of the Aureoid assemblage, and it would key to *Senecio werneriaefolius* A. Gray in my treatment of *Senecio* in North American Flora and subsequent relevant papers (Barkley 1978; 1980; 1988). It differs from *S. werneriaefolius* in possessing a closely felted tomentum, basal leaves that are short, very narrow and tightly revolute, heads that are consistently eradiate and nearly always single, and achenes that are hirtellous. Additionally, *S. spellenbergii* has a distinctive gross aspect, habitat and distribution. It was erroneously assigned to *S. canus* by me in the past, and the type and paratype collections are referred to *S. canus*

in a floristic paper by Spellenberg *et al.* (1986). (N.B. in that publication, the type collection is erroneously cited as no. 7203 instead of no. 7073).

Senecio spellenbergii occurs on caliche soil, in a grassland habitat in the High Plains, some 150 km (90 mi) south of the nearest location of *S. werneriaefolius* which is in the subalpine areas of the San Isabel National Forest west of Trinidad, Colorado, and there the plants are distinctively "typical" for the species. *Senecio spellenbergii* is superficially similar to "Phase no. 4" of *S. werneriaefolius* as described elsewhere by me (Barkley 1980). "Phase no. 4" includes several populations on clay soil in southern Utah, where the plants tend to have close, white tomentum, narrow leaves with revolute margins and a depauperate, sometimes monocephalous aspect. Herbarium studies suggest that these populations are but edaphic extremes in a continuum of variation, and clearly within the geographic and morphological ranges of a highly variable species. A notable example of this extreme form is the following collection: Utah: Garfield Co. Dixie National Forest, Paunsaugunt Plateau, low ridge system north of the East Fork of the Sevier River, 0.4 mi north of Utah Hwy 12, near Coyote Hollow, on open exposed clay slopes with *Pinus aristata*, Sec 2, T36, R4W, elev 7650 ft, 25 May 1968, *J.L. & C.G. Reveal 1017* (KSC). The specimens are small, about 5 cm tall, radiate and with glabrous achenes.

Another relevant collection is: New Mexico: McKinley Co., Zuni Indian Reservation, SE of Zuni in Galestina Canyon, SW side, about 1/2 way up the canyon, R16W, T9N, elev 6500 ft, on N slopes of small box feeder canyon, 3 June 1988, *R. Spellenberg, D. Ward, J. Enote & S. Davis 9501* (KSC; the collection label notes that duplicates are also at ASU,NMC,NY,RSA,UC,Z.I.R.). The plants of this collection are similar to *S. spellenbergii* in aspect, and they have both eradiate heads and hirtellous achenes. However, the mature plants are 7-10 cm tall, which is rather larger than those of *S. spellenbergii* and the heads are frequently two per inflorescence. Furthermore, the field data suggest the collection site is not a distinctive caliche type soil, but rather, the plants are growing "on decayed red Wingate Sandstone overlayed by a gray Zuni Sandstone, with *Pinus edulis, Juniperus monosperma, Cercocarpus*, a few *Pseudotsuga* in upper cooler spots." It is, therefore, easier to regard this collection as a southern extreme of *S. werneriaefolius*, an admittedly complex and polymorphic entity, and to keep *S. spellenbergii* as a restricted and easily circumscribed entity.

It is a pleasure to name this species for Dr. Richard Spellenberg of New Mexico State University, who collected the type materials, and who has made important contributions to the knowledge of the flora of southwestern U.S and northern México.

Senecio scalaris var. **carmenensis** C.C. Freeman, *var. nov.* Figure 6. TYPE
    MÉXICO. Coahuila: Mpio. Villa Acuña, Sierra de Carmen, Canyon de
    Sentenela (= Cañon del Centinel) on Hacienda Piedra Blanca, moist

stream side, July 6, 1936, *F.L. Wynd & C.H. Mueller 546* (HOLOTYPE: NY; Isotypes: GH,MICH,MO,TEX).

Senecio scalaris Greene var. *scalaris* similie, sed foliis tomentosis vel floccosis.

Stout herbaceous perennial 2-5 dm tall. Lower surface of basal leaves and occasionally lower stem sparingly tomentose to floccose-tomentose, lower stem and basal leaves often faintly to deeply anthocyanic. Stems 1-3 from an erect or creeping and branched caudex. Basal leaves mostly pinnatifid, sometimes sublyrate, overall leaf dimensions (2.5-)3.8-11.1 cm long, 0.5-1.8(-2.3) cm wide. Inflorescence a loose corymbiform cyme of (4-)7-20(-35) heads; principal involucral bracts glabrous to sparingly tomentose at the base; achenes glabrous to hirtellous on the angles.

Paratypes: (All from MÉXICO. Coahuila): Higher western ridge on Sierra el Jardin, E of Rancho El Caballo, *Chiang et al. 9335* (LL); Sierra Jardin, *Flyr 1188* (MO); Cañon Humido on N side of Pico Centinel, Sierra el Jardin, 8 km E of Rancho El Jardin, *Johnston et al. 11793* (LL); Sierra Maderas el Carmen at Campo 3, *Wendt & Adamcewicz 502* (LL); Mpio. Ocampo, Sierra Madera el Carmen on upper slope and ridge of peak in upper portion of Oso Canyon between Campo 0 and Campo 5, *Riskind & Patterson 1785* (LL); Madera el Carmen at end of rd above Campo 5 in saddle near viewpoint of W face of Sierra, *Fryxell 2695* (LL,MO).

Senecio scalaris var. *carmenensis* is referable to Group 11d, Aureoidei, in the scheme of Barkley (1985). It is restricted to the Sierra el Carmen, Coahuila, (sometimes written as "Sierra del Carmen") where it occurs at 1500-2500 m in pine-oak woodlands, on sandy or gravelly loam, often derived from rhyolite. Three other aureoids are known in the same region: *S. millelobatus*, *S. coahuilhensis* and *S. obovatus*. *Senecio scalaris* var. *carmenensis* is similar to *S. millelobatus* but may be distinguished by its pinnatifid basal leaves that are pubescent beneath and its winged midrib. By comparison, *S. millelobatus* has pinnate or twice-pinnate basal leaves that are mostly glabrous and that have an essentially unwinged leaf midrib. The systematic position of this new variety is treated in detail by Freeman (1985).

ACKNOWLEDGMENTS

Figure 5. *Senecio spellenbergii* - holotype.

Figure 6. *Senecio scalaris* var. *carmenensis* - isotype.

Mexican Asteraceae, has shared with me his field and herbarium knowledge of the group. Dr. Rupert Barneby of The New York Botanical Garden kindly set the diagnoses of the new species into Latin.

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PUNCTELIA PUNCTILLA (HALE) KROG, NEW TO NORTH AMERICA

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ABSTRACT

Punctelia punctilla (Hale) Krog, previously known only from South Africa, is reported from southern California. Habitat data and the disjunction are discussed.

KEY WORDS: *Punctelia punctilla*, California, North America.

Few *Punctelia* species are found outside temperate or subtropical regions, most occurring in Africa and the Americas (Krog 1982). One species, *P. rudecta* (Ach.) Krog, is known to have a remarkable range that spans several continents in both hemispheres. Thus, it was not surprising to find a closely related species, *P. punctilla* (Hale) Krog (Figure 1), in coastal southern California. *Punctelia punctilla* has previously been known only from South Africa (Krog & Swinscow 1977). Hale & Cole (1988) list *P. borreri* (Sm.) Krog, *P. stictica* (Duby) Krog and *P. subrudecta* (Nyl.) Krog from California. Of these species, *P. punctilla* may resemble *P. stictica* at first glance because of the distinct, white rimmed pseudocyphellae and the darkening lobe tips. However, *P. punctilla* is clearly related to *P. rudecta* due to the presence of isidia, lecanoric acid and a pale lower surface. *Punctelia rudecta* (which is absent in the western states; M.E. Hale, pers. comm.) is a larger, corticolous species with smaller pseudocyphellae and abundant isidia which are coralloid or squamiform with a glossy cortex. The isidia of *P. punctilla* differ in being low, papilliform or sparingly branched with a dull surface. *Punctelia punctilla* is strictly saxicolous. Additional range extensions may be discovered if collections of *P. rudecta* from rock are carefully examined to detect misidentifications of *P. punctilla*.

In California, *P. punctilla* occurs rarely in the Pt. Mugu-Camarillo area of Ventura County. The climate at this site is Mediterranean, and the predominant vascular plant community is coastal sage scrub. As with most of the southern California coastline, agriculture and urbanization have left little natural habitat intact. *Punctelia punctilla* is apparently restricted to a rocky hill region about five kilometers from the ocean at the base of outcrops, mostly on east facing slopes thickly vegetated with *Opuntia littoralis*, *Coreopsis gigantea*, *Salvia leucophylla* and *Artemisia californica*. Characteristic

lichens of these outcrops include *Xanthoparmelia mexicana* (Gyelnik) Hale, *Flavopunctelia flaventior* (Stirton) Hale, *Physcia callosa* Nyl., *Niebla ceruchoides* Rund. & Bowler *in ed.*, *Leprocaulon microscopicum* (Vill.) Gams *ex* D. Hawksw., *Dimelaena radiata* (Tuck.) Hale & Culb., *Acarospora schleicheri* (Ach.) Massal., *Thelomma mammosum* (Hepp *in* Hartung) Massal., *Lecanora gangaleoides* Nyl., *Caloplaca bolacina* (Tuck.) Herre, *Lecanora muralis* (Schreber) Rabenh. and *Buellia halonia* (Ach.) Tuck. It is interesting to note that the author has collected *P. borreri* from similar saxicolous communities along California's southern and central coast. *Punctelia borreri* is also known from South Africa (Krog & Swinscow 1977).

How can one account for such an enigmatic South African–coastal California disjunctive range? This outlying population may be the result of chance long distance dispersal, or it could be considered a relic of an earlier and broader range due to vicariance events, *e.g.*, the allopatric distribution of closely related taxa due to events in geologic history. Long distance dispersal may be the more reasonable explanation when a sorediate species is involved, since isidia are relatively heavy and only transportable over short distances (Ott 1987). Although it is not easy to identify a specific vector/dispersal/pathway, chance long distance dispersal cannot be dismissed as a real possibility. Plants might have been carried along with ballast to nearby Pt. Mugu Naval Station. Also, Croizat (1952) discusses a variant of tracks of the African Gate that conceivably connects southern Africa to points beyond in the New World. On the other hand, a hypothesis supporting vicariance is strengthened when this distribution is viewed as a possible example of a classic pattern (a New World/southern Africa disjunction) for plants which evolved before the continents drifted apart (Hale 1987; Culberson 1972) Whatever the explanation, this new record represents an emerging distribution for *P. punctilla* that may add insight to lichen biogeographic study.
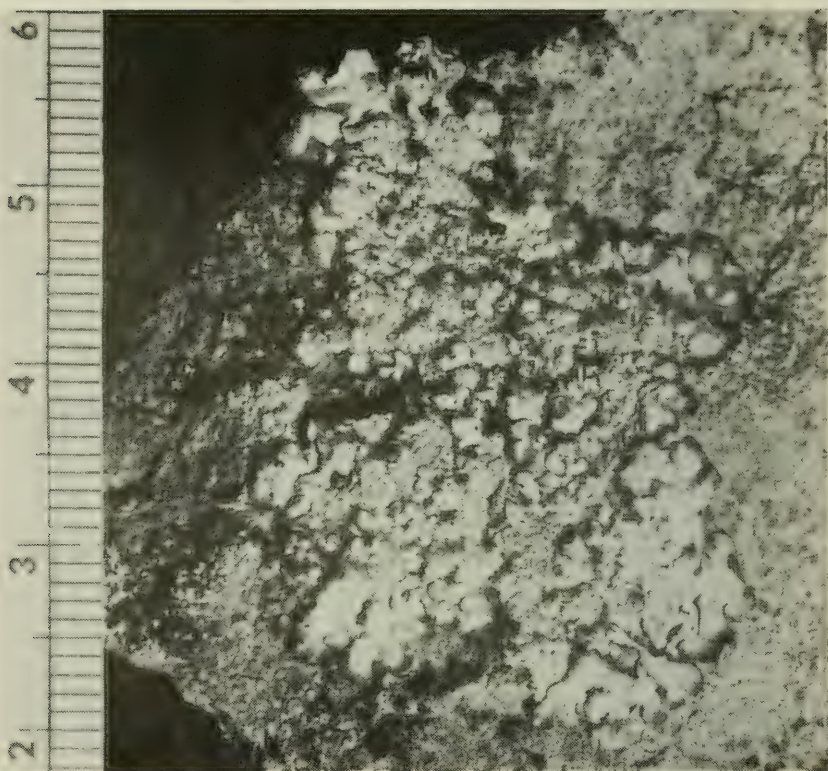
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Figure 1. *Punctelia punctilla* (Hale) Krog from California, Ventura Co.: At base of conglomerate rock on E. Potrero Rd. near Lewis Rd. *Riefner 87-69* (COLO,IRVC,SBM,US), TLC: atranorin and lecanoric acid. At base of outcrop off Lewis Rd. and SE of Camarillo State Hospital, *Riefner 89-20* (IRVC,WIS). TLC: atranorin and lecanoric acid. Solvent systems G, A, C of White & James (1985) used for TLC analyses.

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SMALL SCALE DISTURBANCES AND SUCCESSIONAL DYNAMICS IN A SHORTGRASS PLANT COMMUNITY: INTERACTIONS OF DISTURBANCE CHARACTERISTICS

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ABSTRACT

The effects of interactions among disturbance characteristics on the successional dynamics of small scale disturbances in shortgrass plant communities of north central Colorado, USA, were evaluated by comparing naturally occurring and artificially produced disturbances of different type, seasonality, size, and location by soil texture.

The species composition on the two naturally occurring disturbances (western harvester ant mounds and small animal burrows) were similar one year after plant recovery began, and were different from the composition on the artificially produced plots. The high density and cover of perennials on ant mounds and animal burrows indicated that perennial organs were not killed by the clipping activity of harvester ants or by the pile of soil from burrowing animals. The majority of the cover on the artificially produced plots for two sites differing in soil texture, and most dates and sizes, was attributed to annuals. The importance of seasonality was indicated by the low cover of annuals and perennials on artificial plots produced in September.

Annuals and perennials responded differently to disturbance size. The density of annuals was not affected by the size of the disturbance while the significantly smaller cover values on the smallest compared to the largest plots indicated the effects of competition on the growth of annuals by plants surrounding the plots. Vegetative ingrowth from the edge of the plots resulted in significantly greater cover and density of perennial grasses and sedges on the smallest plots for most dates and both sites than plots of the two larger sizes. The cover and density of the most important perennial forb on the plots, *Sphaeralcea coccinea*, were highest in the center of the largest plots, or the farthest distance from potential competitive interactions with plants in the surrounding undisturbed community.

Although long term monitoring is necessary to evaluate the time required for each disturbed area to be dominated by a shortgrass plant community, the short term results suggest that animal burrows will have

the most rapid recovery time of the disturbance types studied and the largest artificially produced plots will have the slowest recovery time.

KEY WORDS: Disturbance, grassland, *Bouteloua gracilis*, animal burrows, ant mounds, succession.

INTRODUCTION

The disturbance regime of a plant community is composed of a number of disturbance types, each with its associated characteristics (Pickett & White 1985). The rate and pattern of reestablishment of plants following a disturbance is dependent on the life history characteristics of plants available to enter the disturbed site and the characteristics of the site (Sousa 1984). Most studies in grasslands have focused on the independent effects of different disturbance characteristics, including size (Davis & Cantlon 1969), seasonality (Perozzi & Bazzaz 1978) and type, such as ant mounds (King 1977), small burrowing animals (Platt 1975; Hobbs & Mooney 1985), drought (Albertson & Weaver 1944) and comparisons of several types (Collins & Barber 1985; Belsky 1987; Milchunas *et al.* unpublished).

Interactions among disturbance characteristics are also important (Collins & Uno 1983; Collins 1987). However, the nonuniformity of natural disturbances in characteristics such as size and seasonality causes difficulties in evaluating the separate effects of interacting disturbance characteristics. Several researchers have used manipulated plots to control for the heterogeneous characteristics commonly found associated with natural disturbances (Rapp & Rabinowitz 1985; Belsky 1986), but these simulated disturbances are likely not representative of all conditions found on natural disturbances. A comparison of natural disturbances with artificial disturbances of comparable, yet uniform characteristics, is necessary to evaluate the effects of different disturbance characteristics on successional dynamics.

In shortgrass steppe plant communities of the central and southern Great Plains of North America, most successional studies have focused on the independent effects of large scale disturbances, such as abandoned agricultural fields (Savage & Runyon 1937; Judd & Jackson 1939; Costello 1944; Judd 1974; Reichhardt 1982). Small patch producing disturbances are also important, but they have been largely ignored (Coffin & Lauenroth 1988). In shortgrass communities dominated by the perennial grass, blue grama [*Bouteloua gracilis* (H.B.K.) Lag. *ex* Griffiths], disturbances that kill at least one individual *B. gracilis* have the largest potential effect on community structure (Coffin & Lauenroth 1988).

Two examples of small scale disturbances of sufficient intensity and spatial scale to always kill at least one *Bouteloua gracilis* plant are western harvester ant mounds [*Pogonomyrex occidentalis* (Cresson)] and burrows from small mammals, such as skunks (*Mephitis mephitis* and *Spilogale putorius*)

and badgers (*Taxidea taxus*). The effects of these two disturbance types on shortgrass communities are different. Western harvester ants remove the vegetation from around their mounds by clipping the plants below the soil surface while small mammals produce a mound of soil at the surface that covers and kills the vegetation.

Disturbance characteristics, such as size and seasonality, are correlated with different disturbance types and very likely affect succession. The texture of the soil on the disturbed site is also important to plant recovery in shortgrass communities because of the effects of soil texture on plant community composition (Anderson 1983).

Our objective was to evaluate the effects of interactions among disturbance characteristics on the successional dynamics of small scale disturbances in shortgrass steppe plant communities by comparing naturally occurring and artificially produced disturbances of different type, seasonality, size and location by soil texture.

METHODS

Data collection was conducted at the Central Plains Experimental Range (CPER) in north central Colorado, approximately 60 km northeast of Fort Collins (40° 49′ N latitude, 107° 47′ W longitude). Mean annual precipitation over the past 45 years was 311 mm (sd = 79 mm) and mean monthly temperatures ranged from -5° C in January to 22° C in July. Moderate grazing by cattle occurs throughout the area.

Two disturbance locations based on soil texture and with similar climate were chosen: a site with a coarse textured soil (sandy loam) and a site with a fine textured soil (clay to clay loam). Disturbance size was studied by producing artificial plots comparable in size and shape to the range of sizes observed for ant mounds and animal burrows (0.2-1.8 m^2). Seasonality was evaluated by four recolonization dates: September 1 (1984), March 1, May 1 and July 1 (1985). Recolonization date refers either to the date when the artificial disturbances were produced or to the date when ant or animal activity ceased and plant recovery began on the mound or burrow.

Western harvester ant mounds

Previous studies in Wyoming (Kirkham & Fisser 1972) and observations at the CPER indicated that harvester ant mounds rarely occur on sites with fine textured soils; therefore, the location chosen to study plant recolonization on ant mounds was a site on a sandy loam soil. The surface area of each full size mound in a 1.5 ha area was estimated by measuring the longest diameter of each mound and the diameter perpendicular to the first diameter. Eight mounds were randomly assigned to each of the four recolonization dates (Coffin & Lauenroth unpublished).

During the time that western harvester ants inhabit a nest site, the ants inhibit plant growth on the mound by clipping the plants below the soil surface. Therefore, it was necessary to remove the ants in order to study the recolonization of plants on the mounds. Environmental conditions in the nest were altered by placing a plywood box over each of the eight mounds, two weeks prior to the September, May and July recolonization dates. This resulted in the ants relocating their nests. The plywood boxes were ineffective for the March recolonization date since harvester ants overwinter below the soil surface and do not become fully active until late March or mid April (Lavigne 1969). A biocide (Diazinon) was used to kill the ants of the eight mounds for the March date.

Small animal burrows

Observations at the CPER indicated that small animal burrows occur primarily on sites with coarse textured soils with a relatively low frequency of occurrence (0.5 burrows ha^{-1} y^{-1} from Coffin & Lauenroth 1988). Therefore, a large area (5-10 ha) on a sandy loam soil was examined during the time of the study (September 1, 1984-July 1, 1985) for the occurrence of newly formed burrows. Seven burrows were found for one recolonization date, July (1985). Newly formed burrows were not found for the other three dates. Observations at the CPER also indicated that small burrowing animals do not inhibit plant growth on the mound of soil produced by the burrow; therefore plant recovery began immediately after the burrow was produced. The surface area of the mound of soil was estimated by measuring the longest diameter and the diameter perpendicular to the first diameter.

Artificial plots

Artificial plots were produced on two locations differing in soil texture: a coarse and a fine textured soil. Circular plots of three sizes (50, 100 and 150 cm diameter) were produced by removing all above and below ground plant material to a depth of 10 cm. The soil was sieved using a 1 cm mesh screen to remove all perennial organs, then replaced. Eight plots were produced for each site, date and size. A randomized block design was used where plots were located within eight 16x20 m^2 blocks of homogeneous soil and vegetation separated by 10 m borders of undisturbed vegetation within a 0.75 ha area at each site. For each recolonization date, one plot of each of the three sizes was randomly assigned to one of the 20-16 m^2 cells within each block. The result was that the blocks and plots were separated by undisturbed vegetation to allow each plot to be near a source of propagules from the undisturbed plant community.

Data collection and analysis

The number of plants were counted and the percentage canopy cover was estimated by species in early June and late July (1985, 1986) on each of the ant mounds, animal burrows and artificial plots. The sampling dates were chosen to correspond to the maximum development of cool and warm season species. Density and cover values were obtained within concentric circles of 25, 50 and 100 cm in diameter to determine the relative location of each plant within each of the disturbed areas. Total density on each disturbance was found by summing the densities of each circle. The short term effects of the disturbance characteristics on plant recovery were analyzed using data collected one year after plant recovery began on the disturbed areas. Therefore, the data collected for the two sampling dates in 1985 were used for the September (1984) disturbances, while the data collected in 1986 were used for the disturbances of the three dates in 1985.

Because plant recovery on western harvester ant mounds and animal burrows was only monitored on coarse textured soils and the average surface area of ant mounds (0.92 m^2) and burrows from small animals (0.98 m^2) were most similar in size to the 100 cm diameter artificial plots (0.78 m^2), the density and canopy cover of plants on ant mounds and animal burrows were compared with the 100 cm diameter artificial plots on the site with coarse textured soil. The effects of the location of the disturbance by soil type, recolonization date and size were evaluated using the data from the artificial plots.

Analysis of variance was used to evaluate the effects of disturbance type, location by soil texture, date and size on the density and cover of four groups: (1) all plants, (2) perennial grasses and sedges, (3) perennial forbs, shrubs and succulents, and (4) annual grasses and forbs. Tukey's Q values were used to compute least significant ranges (LSR) and to evaluate the significantly different means at the $P<0.05$ level (Sokal & Rohlf 1981).

The composition of the undisturbed plant communities (controls) was determined using fifty 0.25 m^2 quadrats randomly positioned on transects in the vicinity of the disturbances at each of the three sites (artificial plots: coarse and fine textured soils [Coffin & Lauenroth 1989]; ant mound site [Coffin & Lauenroth unpublished]). The density and cover values for the plant communities on the site with coarse textured soil and the ant mound site were used as the control for the effects of disturbance type and seasonality. Because the animal burrows were located in an area that included the ant mound site, the control for ant mounds also represented the control for animal burrows. The number of individuals were counted and canopy cover by species was estimated for each quadrat. The data were collected at the same time as for the disturbances (early June and late July, 1985 and 1986). The values for the four sampling dates were used in an analysis of variance to evaluate the effect of soil type on the density and cover of the four groups of species for the

undisturbed plant communities.

RESULTS

The undisturbed plant communities of the ant mound site and the sites with coarse and fine textured soils for the artificial plots were typical of shortgrass communities (Sims *et al.* 1978) by having greater than 60% of their total density and 80% of their total cover attributed to perennial grasses and sedges (Table 1). The plant communities were dominated by the perennial grass, *Bouteloua gracilis* which contributed greater than 70% to the total cover. Other important perennial grasses and sedges were *Carex heliophila* Mack. (sunsedge) and *Buchloe dactyloides* (Nutt.) Engelm. (buffalograss). [Nomenclature follows McGregor (1986)].

The plant communities at the site with coarse textured soil and the ant mound site were similar and significantly different from the plant community at the site with fine textured soil for all groups except perennial grasses and sedges. Density and cover of annuals [primarily *Vulpia octoflora* = *Festuca octoflora* (Walt.) Rydb. (sixweeksgrass)] were significantly higher on the site with fine textured soil, while the density and cover of perennial forbs, shrubs and succulents were significantly higher on the other two sites. The succulent, *Opuntia polyacantha* Haw. (plains pricklypear) and the perennial forb, *Sphaeralcea coccinea* (Pursh) Rydb. (scarlet globemallow) were important contributors to density and cover on all three sites, while the shrubs *Chrysothamnus nauseosus* (Pall.) Britt. (rabbitbrush), *Gutierrezia sarothrae* (Pursh) Britt. & Rusby (broom snakeweed) and *Atriplex canescens* (Pursh) Nutt. (four wing saltbush) occurred primarily on the site with coarse textured soil and the ant mound site.

Species composition and disturbance type

The density and cover of the four groups of species were different for the three disturbance types, although the species found on the disturbances were similar. The first year after western harvester ant mounds were vacated, most of the density (>70%) and canopy cover (>80%) of plants on the mounds were perennials (Figures 1;2), including forbs (*Sphaeralcea coccinea, Oenothera caespitosa* Nutt. (evening primrose) and *Picrodeniopsis oppositifolia* (Nutt.) Rydb. (plains bahia), the succulent (*Opuntia polyacantha*), the subshrub [*Artemisia frigida* Willd. (fringed sagewort)], the grasses [*Sporobolus cryptandrus* (Torr.) A. Gray (sand dropseed) and *Sitanion hystrix* Nutt. (squirreltail)] and the sedge *Carex heliophila*. Important annual species were *Vulpia octoflora, Plantago patagonica* Jacq. (Patagonian plantain) and *Lepidium densiflorum* Schrad. (prairie pepperweed). For most dates, the density and cover of perennial forbs, shrubs and succulents on ant mounds were greater than

Table 1. Average density and canopy cover of four groupings of species for three undisturbed plant communities.

	Fine Textured Soil[1]	Coarse Textured Soil[1]	Ant Mound Site[2]
Density (no./m^2)			
Perennial grasses and sedges	86	81	72
Perennial forbs, shrubs and succulents	8*	16	19
Annual grasses and forbs	41*	14	10
Total	134*	112	101
Canopy Cover (%)			
Perennial grasses and sedges	38	38	41
Perennial forbs, shrubs and succulents	4*	7	8
Annual grasses and forbs	2*	1	1
Total	44*	46	49

* indicates significance at $P<0.05$ among sites for each species group
[1] from Coffin & Lauenroth (1989)
[2] from Coffin & Lauenroth (unpublished)

perennial grasses and sedges while the reverse was true for the surrounding undisturbed vegetation.

Most density (71%) and cover (53%) of plants on the mound of soil from small animal burrows were from perennial grasses and sedges (Figures 1;2). Large contributions to density (23%) and cover (44%) were also made by perennial forbs, shrubs and succulents. The same species of perennial plants were found on animal burrows as for ant mounds with the addition of a large contribution to cover by *Bouteloua gracilis* (20%). Relatively few annuals were found on the burrows and were primarily the forb species, *Chenopodium album* L. (lamb's quarters). Although the density of perennial grasses was significantly higher on the burrows than in the surrounding vegetation, the cover of perennial grasses was significantly lower (Figures 1;2).

In contrast to ant mounds and animal burrows, the densities of annuals, perennial grasses and perennial forbs, shrubs and succulents were comparable within and among dates on the 100 cm diameter artificial disturbances on the site with coarse textured soil, while the total densities of plants were comparable among dates (Figure 1). Greater than 43% of the total cover on the plots was due to annuals and more than 33% was due to perennial forbs, shrubs and succulents (Figure 2). Important species on artificial plots were the perennials: *Sphaeralcea coccinea, Oenothera caespitosa, Picrodeniopsis oppositifolia, Carex heliophila, Sporobolus cryptandrus, Sitanion hystrix* and *Buchloe dactyloides*, and the annuals: *Vulpia octoflora, Lepidium densiflorum, Plantago patagonica* and *Chenopodium album*. Significantly lower density and cover of perennial grasses occurred on the artificial plots than for the surrounding undisturbed vegetation and for most dates, the cover of annuals was significantly higher on the plots than for the controls.

Disturbance type and recolonization date

The highest total density (228 plants/m^2) and canopy cover (30%) of the three disturbance types were found on animal burrows (Figure 3). For most dates, ant mounds had intermediate density (66-227 plants/m^2) and cover values (14-25%) while artificial plots had the lowest density (29-70 plants/m^2) and cover (8-20%). Significant effects of recolonization date were the result of low cover values on artificial plots produced in September.

The density (162 plants/m^2) and cover (16%) of perennial grasses and sedges on animal burrows were significantly higher than on ant mounds or artificial plots (Figure 4). Most of the perennial grasses and sedges on the three disturbance types were from individuals of the rhizomatous species, *Carex heliophila*. For most dates, the lowest density and cover values were found on the artificial plots. The low cover values for the September artificial plots (0.2%) were the significant date effects for perennial grasses and sedges.

Ant mounds and animal burrows had higher density (30-116 plants/m^2) and cover (9-17%) of perennial forbs, shrubs and succulents for all recoloniza-
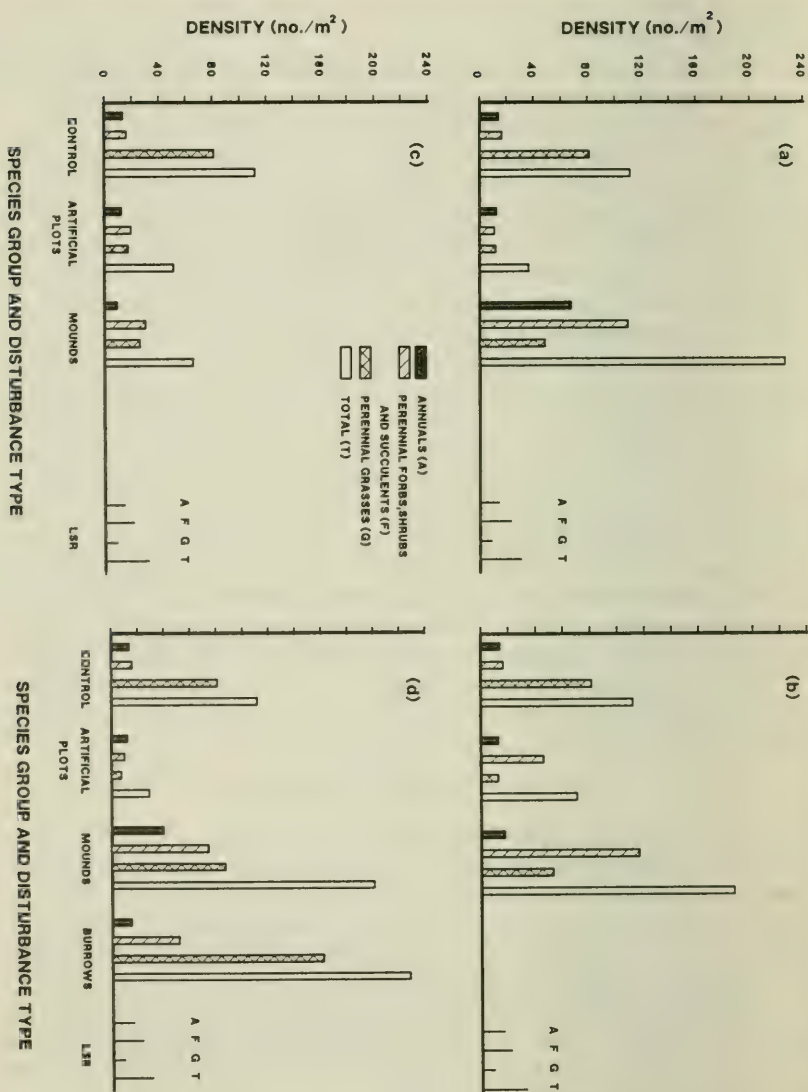
Figure 1. Density of plants of four groups of species for three disturbance types and the control for four recolonization dates (a) September, 1984 (b) March, 1985 (c) May, 1985 (d) July, 1985. Use LSR_A for significance of annuals between disturbance types and the control and within dates, LSR_F for perennial forbs, shrubs and succulents, LSR_G for perennial grasses and sedges, and LSR_T for total density.
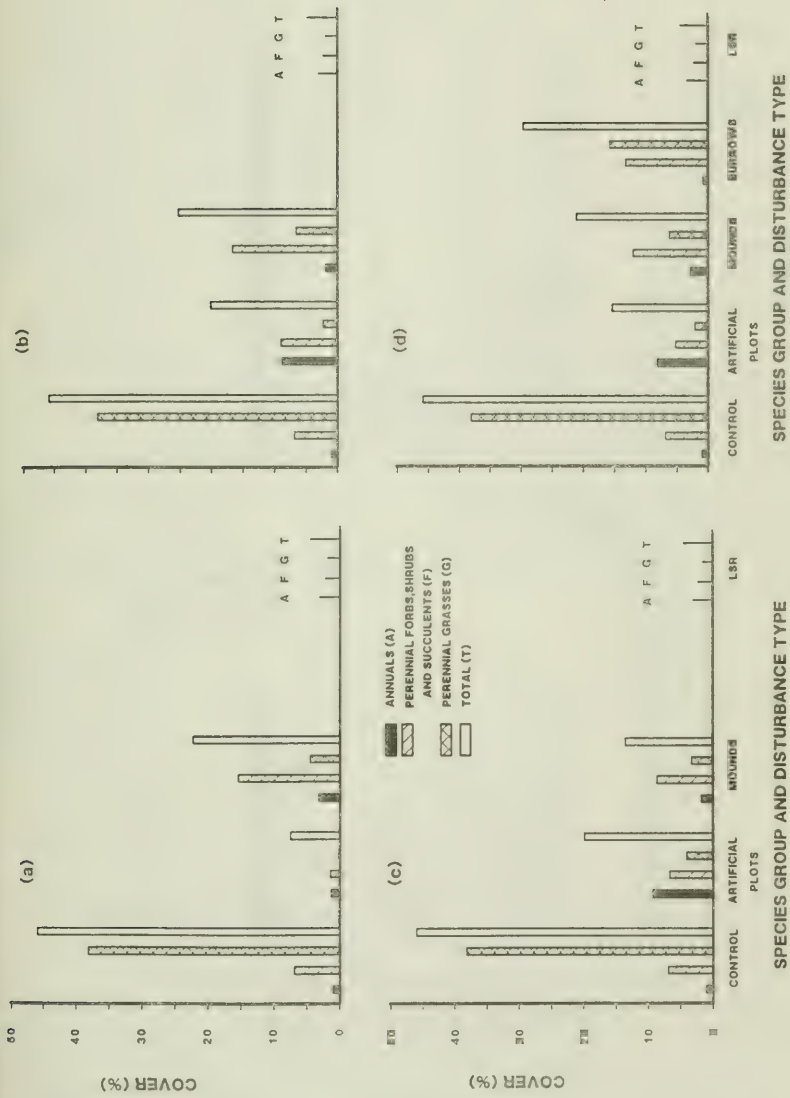
Figure 2. Cover of plants for four groups of species for three disturbance types and the control for four recolonization dates (a) September, 1984 (b) March, 1985 (c) May, 1985 (d) July, 1985. For explanation on use of significance ranges (LSR) see Figure 1.

Figure 3. Density and cover of plants for three disturbance types and the control for four recolonization dates. Use LSR_2 for significance of type within dates and LSR_1 for significance of date within types.
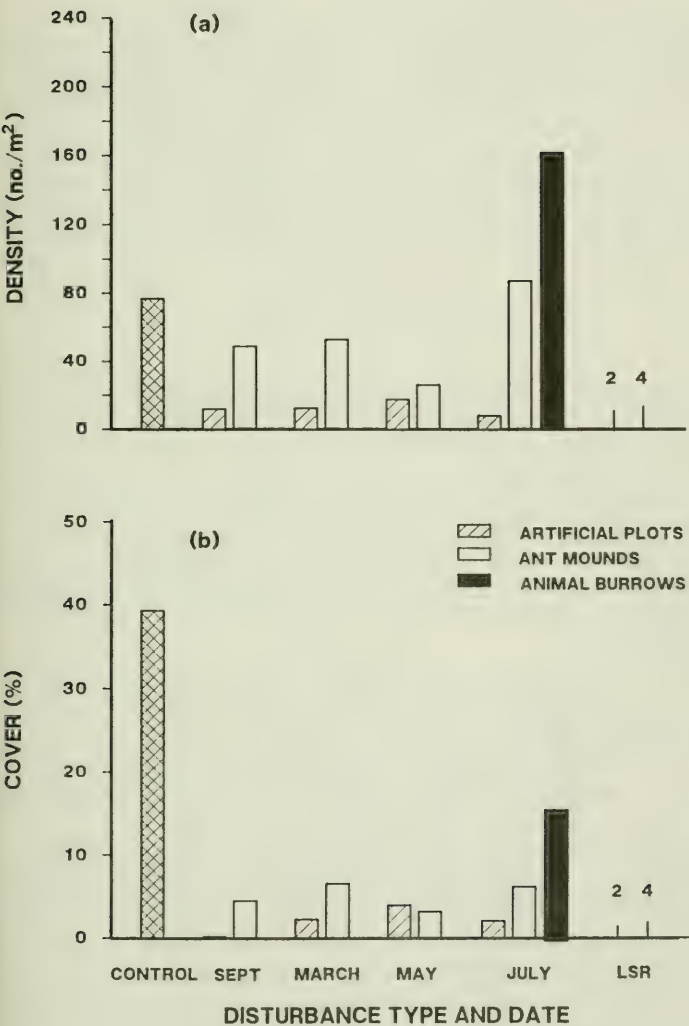
Figure 4. Density and cover of perennial grasses and sedges for three disturbance types and the control for four recolonization dates. For explanation on use of significance ranges (LSR) see Figure 3.

tion dates than the artificial plots (Figure 5). *Sphaeralcea coccinea* was the most important species in this group for the three disturbance types. Significant date effects were the result of high densities on the March plots and low cover values on the September plots. The density of annual plants was comparable on the three disturbance types, except for the high densities of annuals found on ant mounds vacated in September (Figure 6a). The percentage cover of annuals was significantly higher on artificial plots than on mounds or burrows for all dates except September (Figure 6b). Most of the cover on the artificial plots was attributed to two species, *Lepidium densiflorum* and *Vulpia octoflora*.

Disturbance location, date and size

Similar species were found on the artificial plots at the sites with fine and coarse textured soils, although the density and cover values of the four groups of species were significantly different. The total density of plants on artificial plots at the site with fine textured soil (33-211 plants/m^2) was higher for all sizes and all dates than the density of plants on plots at the site with coarse textured soil (34-81/m^2) (Figure 7). Densities on the disturbed plots were comparable for most dates and sizes within each site. The percentage canopy cover on artificial plots at the site with fine textured soil was significantly greater than plots at the site with coarse textured soil for all dates except September (Figure 7c).

Similar density and cover values of perennial grasses were found for both sites, although the values on the plots were less than on the controls (Figure 8). The 50 cm diameter plots had significantly higher density values, due to *Carex heliophila* on the site with fine textured soil and *Buchloe dactyloides* on the site with coarse textured soil, than the 100 cm or 150 cm diameter plots for both sites and most dates.

The density of perennial forbs, shrubs and succulents on the artificial plots for both sites were comparable to or significantly greater than the controls (Figure 9a,b). The March plots on the site with fine textured soil had significantly greater density values for all three plot sizes than the plots for the other dates primarily because of differences in the densities of *Sphaeralcea coccinea* (Figure 9b). In most cases, the 50 cm diameter plots had the smallest density values of the three sizes within a date and site. Although the percentage cover of perennial forbs, shrubs and succulents was significantly different for the two controls, significant site differences were not found for the cover of plants on the plots (Figure 9c). The plots produced in September had significantly smaller cover values for all three sizes than plots for the other three dates.

The density and cover of annuals was higher for the three plot sizes on the site with fine textured soil and the control vegetation than for plots on the site with coarse textured soil (Figure 10a,b). Significantly greater density and
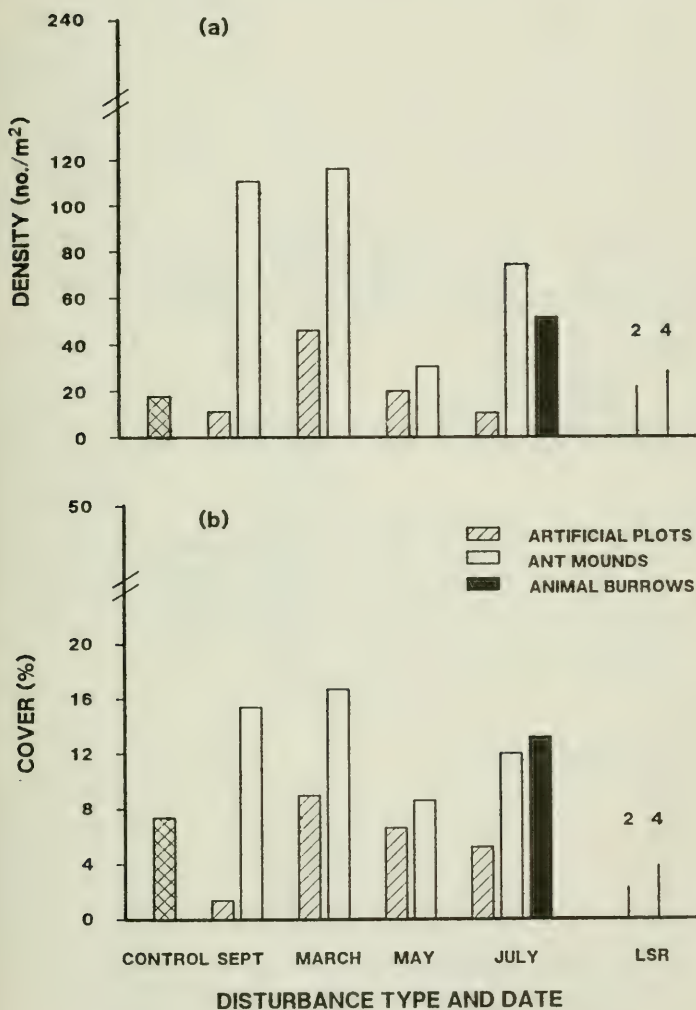
Figure 5. Density and cover of perennial forbs, shrubs and succulents for three disturbance types and the control for four recolonization dates. For explanation on use of significance ranges (LSR) see Figure 3.
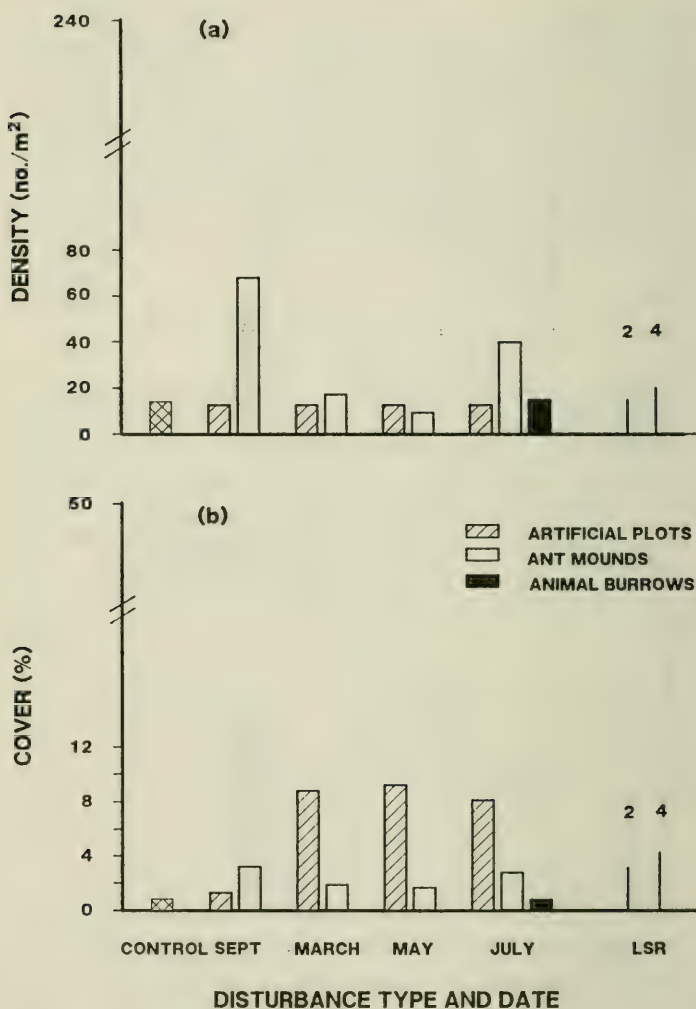
Figure 6. Density and cover of annuals for three disturbance types and the control for four recolonization dates. For explanation on use of significance ranges (LSR) see Figure 3.
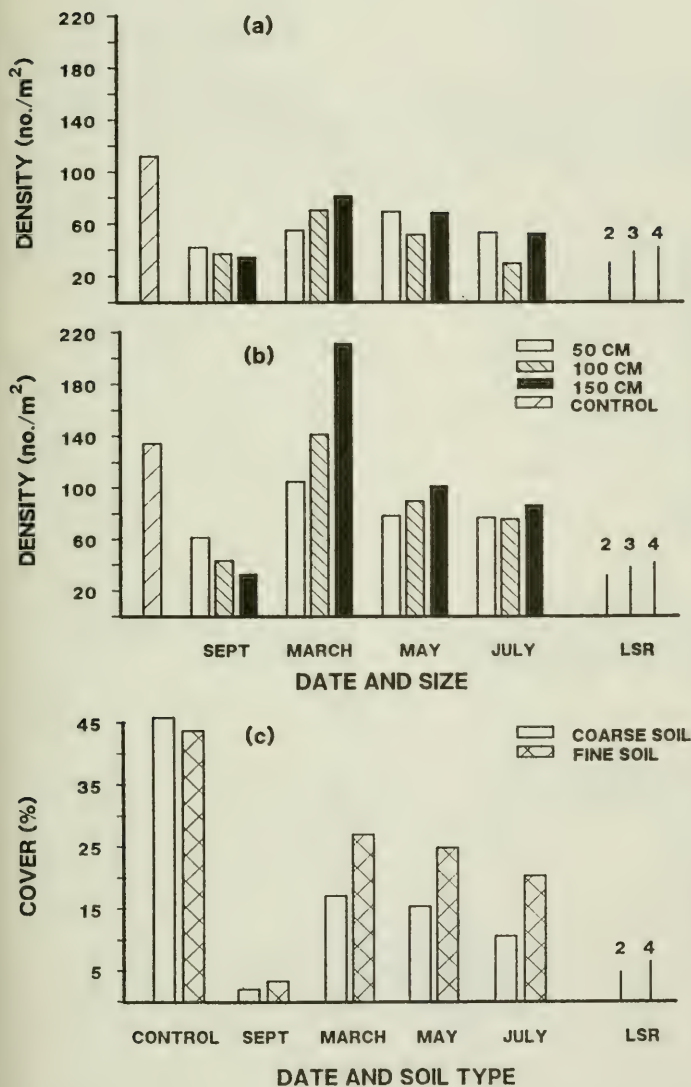
Figure 7. Density of plants on artificial plots of three sizes for four dates, and the control for two sites (a) coarse textured soil (b) fine textured soil. (c) Cover of plants on artificial plots of three sizes for four dates. Use LSR_2 for significance of site within size and date, LSR_3 for size within site and date, and LSR_4 for date within site and size.
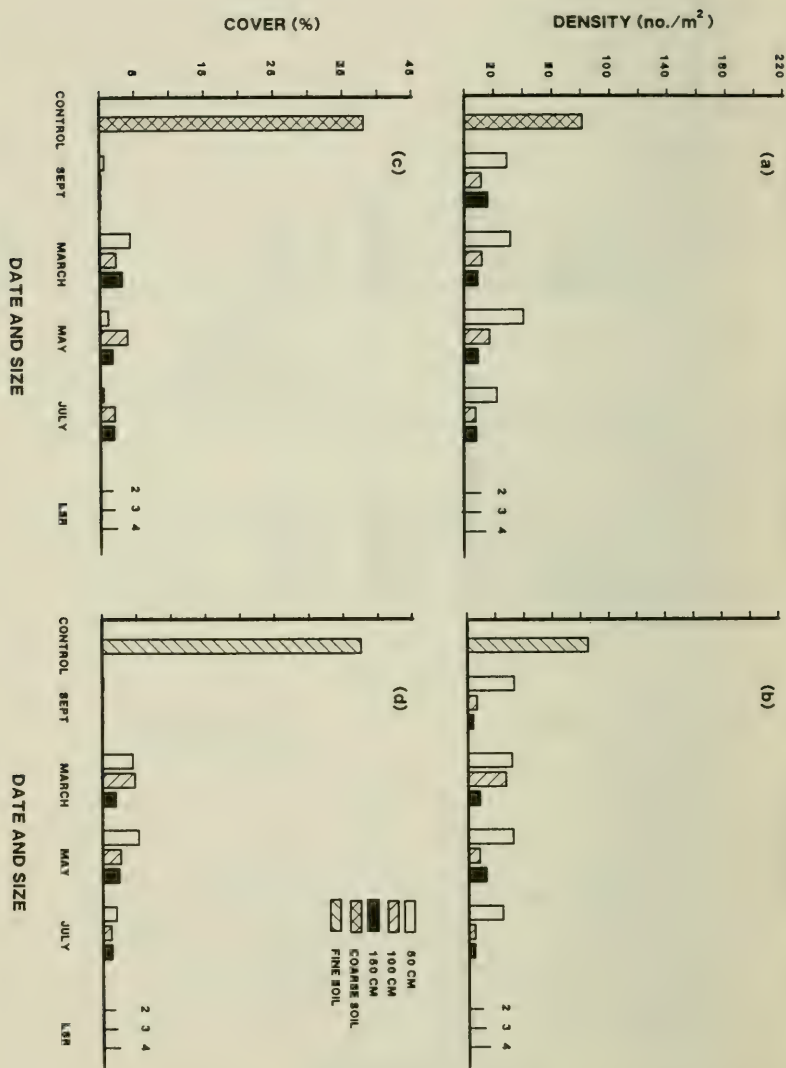
Figure 8. Density of perennial grasses and sedges on artificial plots of three sizes for four dates, and the control for two sites (a) coarse textured soil (b) fine textured soil. Cover of perennial grasses on artificial plots of three sizes for four dates, and the control for two sites (c) coarse textured soil (d) fine textured soil. For explanation on use of significance ranges (LSR) see Figure 7.
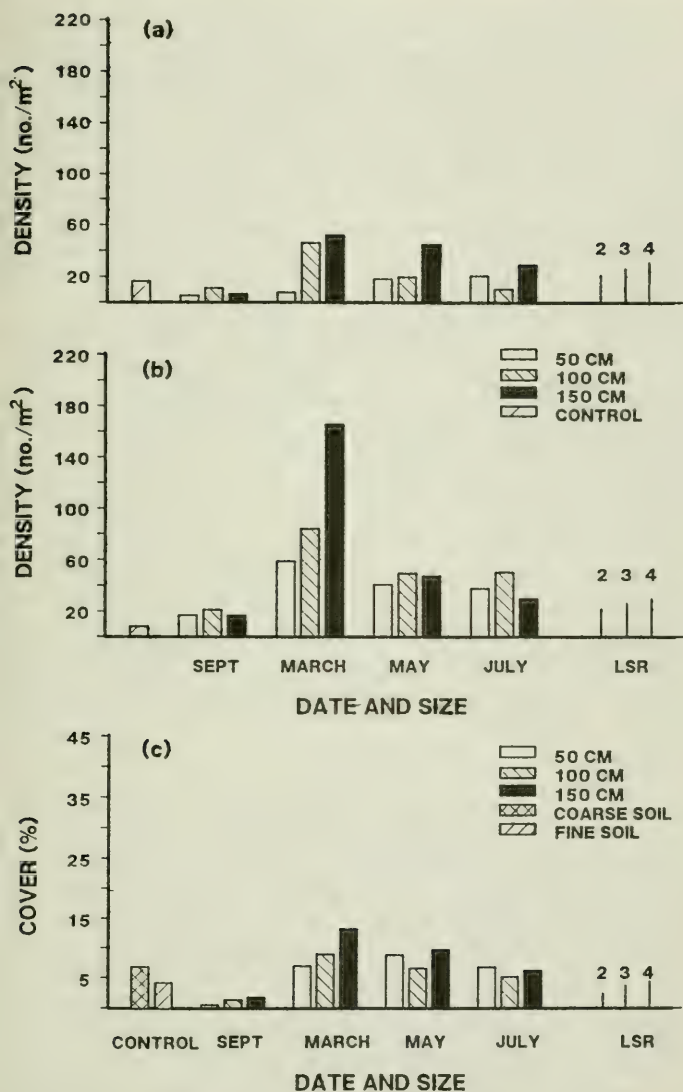
Figure 9. Density of perennial forbs, shrubs and succulents on artificial plots of three sizes for four dates, and the control for two sites (a) coarse textured soil (b) fine textured soil. (c) Cover of perennial forbs, shrubs and succulents on artificial plots of three sizes for four dates, and the control for two sites by soil texture. For explanation on use of significance ranges (LSR) see Figure 7.

cover values of annuals (primarily *Lepidium densiflorum* and *Chenopodium album*) were found on the 150 cm diameter plots than on the 50 cm diameter plots for the site with fine textured soil. The September plots had significantly lower cover values of annuals than plots for the other three dates (Figure 10c).

An analysis based on the density and cover of plants located in the 50 cm diameter center circle of each artificial plot was conducted to further evaluate the effects of disturbance size on plant recovery. Other factors besides perimeter and surface area, such as microenvironmental gradients and the ability of plants to disperse over the entire plot, may change as plot size changes, and would be indicated by a difference in the density and cover of plants in the center of the different sizes of plots.

The total density of plants located in the center circle of each plot was higher on the 50 cm diameter plots than the 100 cm or 150 cm diameter plots for both sites and most dates (Figure 11a,b). Although total density was higher on the 50 cm diameter plots, percentage canopy cover was significantly higher on the 100 cm (18%) and 150 cm (19%) than on the 50 cm diameter plots (11%). Significantly higher density and cover values were found for perennial grasses and sedges (primarily *Carex heliophila* and *Buchloe dactyloides*) for the 50 cm diameter plots than for the 100 cm or 150 cm diameter plots on both sites (Figure 12). Size was not a significant factor for the density or cover of perennial forbs, shrubs and succulents except for the high density and cover values on the March 150 cm diameter plots, due to *Sphaeralcea coccinea* (Figure 13). Although the densities of annuals were not affected by disturbance size, the cover values were significantly higher on the 100 cm (10%) and 150 cm diameter plots (11%) than on the 50 cm diameter plots for all dates (3%).

DISCUSSION

The species composition on the two naturally occurring disturbances (western harvester ant mounds and small animal burrows) were similar one year after plant recovery began, and were different from the composition on the artificially produced disturbances. This distinction between natural and human caused disturbances was also found for grasslands and savannas of the Serengeti National Park (Belsky 1987). The high density and cover of perennials on ant mounds and animal burrows indicate that perennial organs, such as rhizomes of *Carex heliophila* and tap roots of *Sphaeralcea coccinea*, were not killed by the clipping activity of harvester ants or the pile of soil from burrowing animals. Similar growth of perennial grasses and forbs on badger mounds was observed in the first growing season in a tallgrass prairie (Platt 1975).

The recolonization of western harvester ant mounds was primarily by perennials, and the density of annuals on the mounds was significantly greater than on animal burrows and most artificial plots. The activities of western harvester ants may affect the recovery of plants on abandoned mounds in several
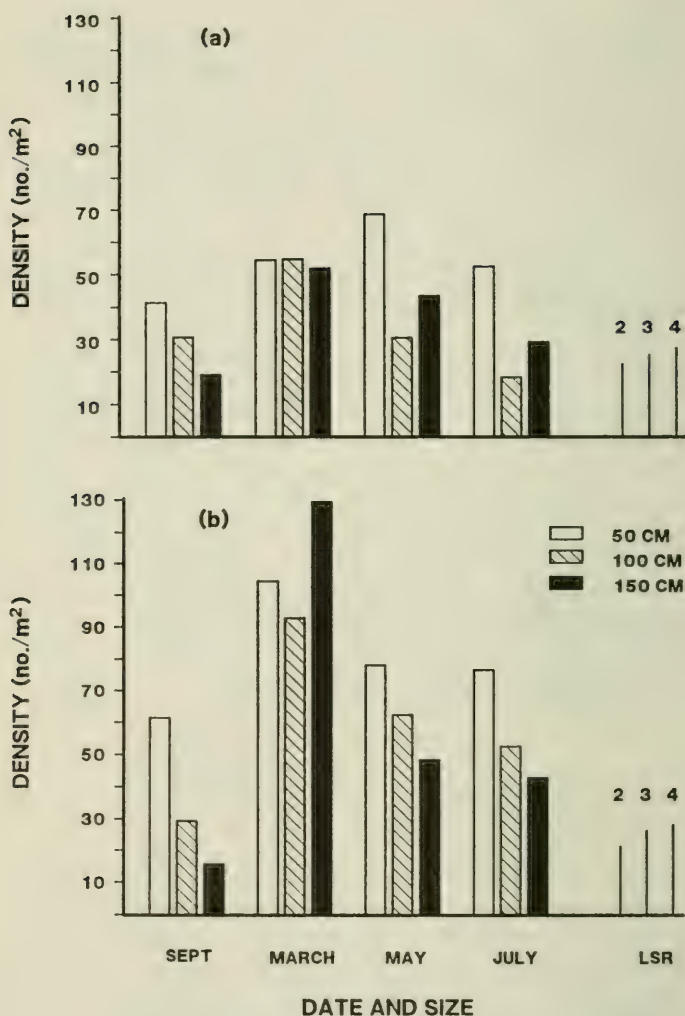
Figure 10. (a) Density of annuals on artificial plots of three sizes for four dates, and the control for two sites by soil texture. (b) and (c) Cover of annuals on artificial plots of three sizes for four dates, and the control for two sites by soil texture. For explanation on use of significance ranges (LSR) see Figure 7.

Figure 11. Density of plants in the center 50 cm diameter circle of artificial plots of three sizes for four dates and two sites (a) coarse textured soil (b) fine textured soil. For explanation on use of significance ranges (LSR) see Figure 7.
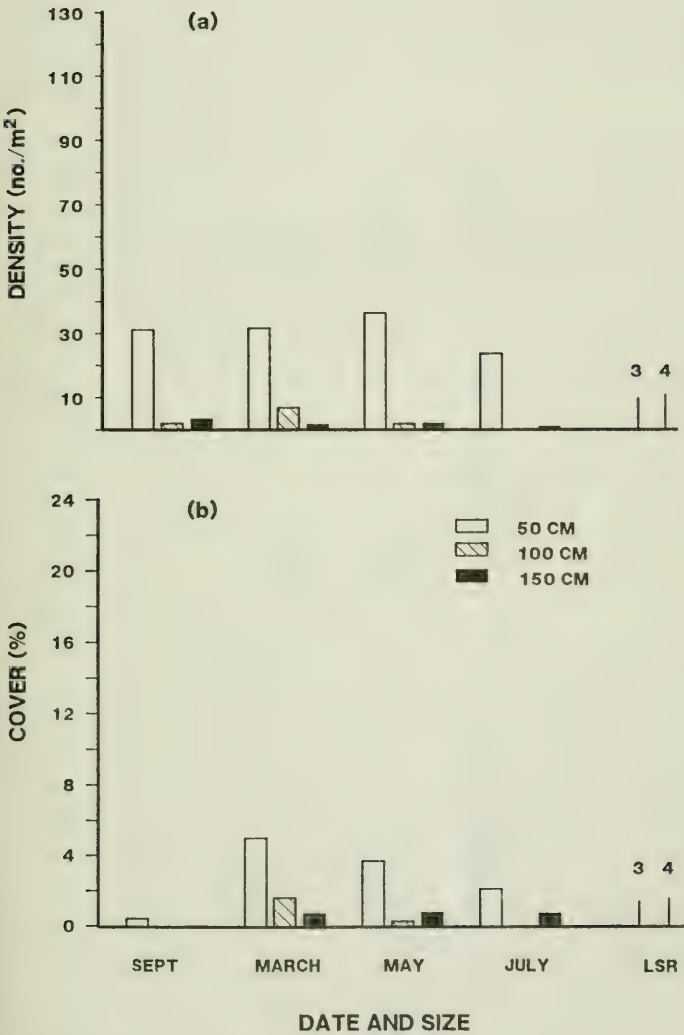
Figure 12. Density and cover of perennial grasses and sedges in the center 50 cm diameter circle of artificial plots of three sizes for four dates. Use LSR₃ for significance of size within date and LSR₄ for date within size.
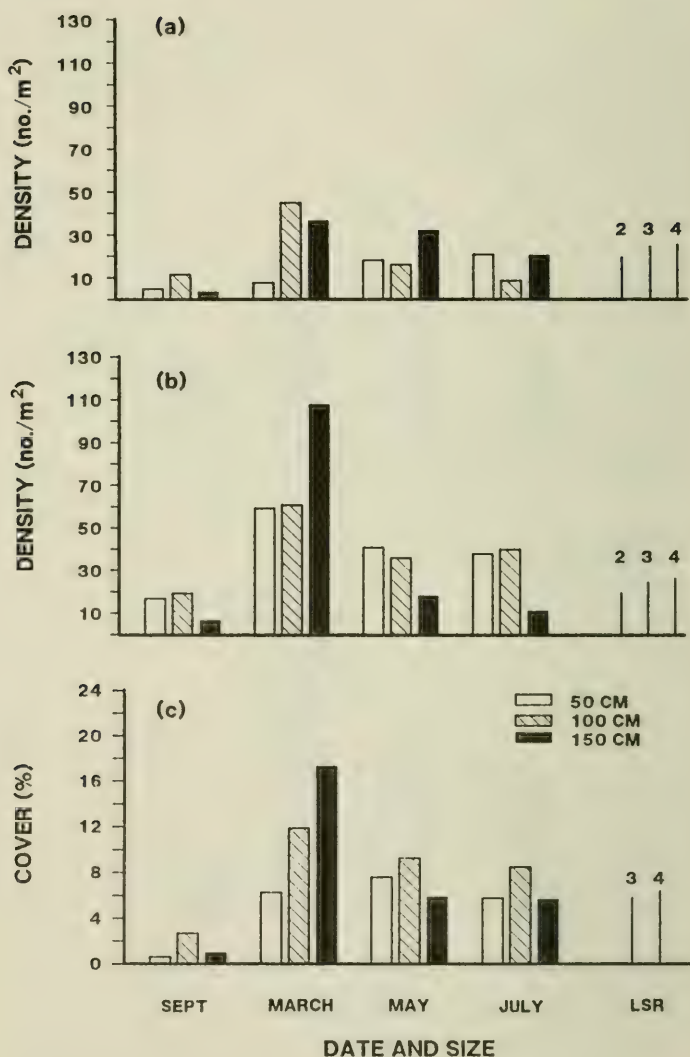
Figure 13. Density of perennial forbs, shrubs and succulents in the center 50 cm diameter circle of artificial plots of three sizes for four dates and two sites (a) coarse textured soil (b) fine textured soil. For explanation on use of significance ranges (LSR) see Figure 7. (c) Cover of perennial forbs, shrubs and succulents in the center 50 cm diameter circle of artificial plots of three sizes for four dates. For explanation on use of significance ranges (LSR) see Figure 12.

ways due to the interactions of ants with their environment during the 30-60 years that a colony may inhabit a nest site (Wiens 1976; Coffin & Lauenroth unpublished). The foraging and clipping activities of the ants affect the microenvironmental conditions on the nest as well as the availability of reproductive and vegetative propagules.

Nutrients and seeds are concentrated in a nest as a result of the foraging and storage of seeds and other organic materials in underground chambers by harvester ants, and soil water is significantly higher ($P<0.05$) in a nest than at points away from the nest due to the clipping of all plants from the mound (Rogers 1974; Rogers & Lavigne 1974). The significantly greater ($P<0.05$) standing crop of plants surrounding a mound compared to points located away from the mound (Rogers & Lavigne 1974) may also result in an increased availability of seeds and vegetative propagules to an abandoned mound compared to disturbances that are recolonized immediately after being produced (artificial plots and animal burrows). The number of germinable seeds found near the soil surface of mounds in September, 1984 (6756 seeds/m^2 from Coffin & Lauenroth unpublished) was significantly greater ($P<0.05$) than the number of seeds in the soil at the site with coarse textured soil for the same date (2748 seeds/m^2 from Coffin & Lauenroth 1989). The length of time these conditions persist on an abandoned mound is unknown. However, the largest effects on plant recovery most likely occur in the short term.

The 6% cover by the dominant plant species, *Bouteloua gracilis*, on animal burrows was primarily due to the vegetative growth of *B. gracilis* plants partially covered by soil. *Bouteloua gracilis* was not found in significant amounts on ant mounds or artificial plots. These results suggest that the time required for *B. gracilis* to dominate the plant community on animal burrows will be less than for ant mounds or artificial plots, and less than the estimated recovery time of greater than 50 years for *B. gracilis* to dominate abandoned agricultural fields (Reichhardt 1982). The recovery time for abandoned fields was based on the observation that it took 33 years for *B. gracilis* to occur on the fields and another decade to reach 2% in frequency of occurrence (Reichhardt 1982).

In contrast to ant mounds and animal burrows, the majority of the cover on the artificially produced disturbances for the sites with coarse and fine textured soils, and most dates and sizes, was attributed to annuals. This is similar to plant communities found on old roads and abandoned agricultural fields in the shortgrass steppe region within five years after the beginning of plant recovery (Shantz 1917; Costello 1944; Judd 1974; Reichhardt 1982). Perennials colonized the artificial plots in the first year as indicated by the comparable densities of annuals, perennial grasses and sedges, and perennial forbs, shrubs and succulents.

The recolonization date and size of the disturbance had important effects on the density and cover of plants on artificial plots. The effects of recoloniza-

tion date on short term successional dynamics are due to interactions between the availability of propagules to the site and the microenvironmental conditions on the site relative to the requirements for germination, establishment and growth of the propagules (Sousa 1984). The low cover of annuals and perennials on artificial plots produced in September may be a combination of: (1) the seasonal dynamics in the relatively few germinable seeds stored in the soil at the two sites (964 seeds/m^2 averaged over two years from Coffin & Lauenroth 1989), (2) the low and variable patterns of precipitation found in the shortgrass region (Sala & Lauenroth 1982), and (3) the timing of the precipitation events relative to factors such as temperature. Because of the variability in precipitation within and among years, conducting the study in another year would most likely indicate the timing of the disturbance to have important effects on plant recovery, however, the specific effects observed in this study may not occur.

Although annuals and perennials responded similarly to the effects of recolonization date, they responded differently to disturbance size. The size of the disturbance may be important to the availability of propagules to the disturbed site and the resources available to the propagules. As disturbance size increases, propagules must disperse over larger distances to colonize the entire disturbed area, while competition from plants around the edge increases as the size of the disturbance decreases (Sousa 1984).

The source of propagules for annuals included seeds stored in the soil and the dispersal of seeds onto the plot. The density of annuals was not affected by disturbance size while the effects of competition by plants surrounding the plots on the growth of annuals was indicated by the significantly smaller cover values on the smallest compared to the largest plots.

Perennials may recover either from seedling establishment or vegetative growth. Relatively few perennial grass or perennial forb, shrub and succulent seeds were found stored in the soil compared to annual seeds (Coffin & Lauenroth 1989). Most of the perennials on the plots were the result of vegetative growth by *Carex heliophila, Buchloe dactyloides* and *Sphaeralcea coccinea*. The recovery of *C. heliophila* by rhizomes and *B. dactyloides* by stolons occurred as ingrowth from the edge of the plots. The greater perimeter to area ratio of small compared to large plots (Miller 1982; Sousa 1984) resulted in significantly greater cover and density values of perennial grasses and sedges on the smallest plots for most dates and both sites.

The cover of the perennial forb, *Sphaeralcea coccinea*, responded similarly to disturbance size as annuals by having the highest values in the center circle of the largest plots, or the farthest distance from potential competitive interactions with plants in the surrounding undisturbed community. Although the density of annuals was not affected by disturbance size, the density of *S. coccinea* responded similarly to the cover values. The recovery of this important forage species (Hyder *et al.* 1975) was primarily from deep tap roots either

from plants at the edge of the plot or by regrowth of plants on the plot.

The interaction between disturbance size, recolonization date and location by soil texture was also important to the cover and density of *Sphaeralcea coccinea*. The period of growth of this species (April and early May from Dickinson & Dodd 1976) corresponds to the significantly greater density and cover values on the largest plots cleared in March on the site with fine textured soil for perennial forbs, shrubs and succulents than for plots of the other dates. Similar results on the importance of the timing of the availability and growth of propagules relative to the seasonality of the disturbance were found for the recovery of an annual grassland following small disturbances (Hobbs & Mooney 1985).

Although the long term monitoring of the disturbed sites for the three disturbance types and their associated characteristics is necessary to evaluate the time required for each disturbed area to be dominated by a shortgrass plant community, the results after one year of recovery suggest that animal burrows will have the most rapid recovery time of the disturbance types studied because of the presence of *Bouteloua gracilis* and other perennials on the burrows. Artificial plots, and in particular the largest plots, will have the slowest recovery time since relatively few perennials were found on the plots compared to ant mounds or animal burrows.

ACKNOWLEDGMENTS

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BOOK REVIEWS

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Atlas Florae Europaeae Distribution of Vascular Plants in Europe, Vol.
I, Part 1, Pteridophyta (Psilotaceae to Azollaceae); Part 2, Gymnosper-
mae (Pinaceae to Ephedraceae). Jaakko Jalas & Juha Suominen, eds.
Cambridge University Press, 32 East 57th Street, New York, NY, 10022,
USA. 1989, 121 pp. (Part 1), 43 pp. (Part 2), + 4 pp. appendix, $59.50,
cloth. ISBN 0-521-34270-8.

Atlas Florae Europaeae Distribution of Vascular Plants in Europe, Vol.
II, Part 3, Salicaceae to Balanophoraceae; Part 4, Polygonaceae; Part
5, Chenopodiaceae to Basellaceae. Jaakko Jalas & Juha Suominen, eds.
Cambridge University Press, 32 East 57th Street, New York, NY, 10022,
USA. 1989, 122 pp. (Part 3), 69 pp. (Part 4), 124 pp. (Part 5), + 4 pp.
appendix, $69.50, cloth. ISBN 0-521-34271-6.

Atlas Florae Europaeae Distribution of Vascular Plants in Europe, Vol.
III, Part 6, Caryophyllaceae; Part 7, Caryophyllaceae (Silenoideae).
Jaakko Jalas & Juha Suominen, eds. Cambridge University Press, 32
East 57th Street, New York, NY, 10022, USA. 1989, 168 pp. (Part 6),
237 pp. (Part 7), + 4 pp. appendix, $89.50, cloth. ISBN unknown.
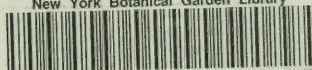
These three volumes, which parallel volumes of the *Florae Europaeae* series,
compile records of geographic distributions of the plants of Europe. The range
of each taxon is shown on a map of Europe (or in some cases a map of part
of Europe). Distribution information is coded onto a 50 km grid system and
a symbol placed on the map corresponding to the grid location if a represen-
tative of the taxon has been reported from within the unit. Due to landform
irregularities (particularly coastlines and islands), some deviations from the
strict pattern of the grid system are necessary and these deviations are cited
in the introductory matter for each volume. Taxonomic differences from the
Florae Europaeae are also noted in each volume. The methods employed in
producing these maps have some inherent shortcomings, as were pointed out
by Holub (Norrlinia 2:107-115 [1984]) and summarized in the prefaces of vol-
umes I and II. Many of these shortcomings are surmountable and should allow
any future editions to be much improved. The maps are easy to read and plant

distributions may be observed quickly. The appendix in each volume is a set of 2 maps showing the location of the grid units used in the mapping system. A single page landform map in each volume might be helpful to workers not familiar with European landforms. Also, a single set of page numbers within each volume would make the series easier to use and simplify citations. The most significant difficulty I experienced with these three volumes is that the first 58 pages of my copy of volume III are the first 58 pages of volume II. I trust that this is an error in binding which did not occur in many copies.

McGraw-Hill Concise Encyclopedia of Science and Technology, 2nd ed. Sybil P. Parker, ed. McGraw-Hill Publishing Co., New York. 1989, lxxvi, 2222 pp., illus., price unknown, cloth. ISBN 0-07-045512-0.

"Concise encyclopedia" strikes me as a *non sequitur*, much like "jumbo shrimp" and "army intelligence." It is probably impossible to be both encyclopedic and concise in the same document. This book suffers from the attempt to achieve that goal. The terms that are treated in the work are given lengthy definitions and descriptions of their use, and many are accompanied by illustrations. However, in order to treat terms at length and cover the entire spectrum of science and technology, only a relatively limited set of terms may be considered. Therefore, many useful terms are left out. The method for selection of terms is not clear. It would seem that defining the more general terms and omitting the more narrow would be appropriate for this work but, this does not seemd to be the case. For instance, lichens are included, symbiosis is not. On the other hand, superfluous information is included for some of the definitions. For example, the entry for each element in the periodic table is accompanied by a copy of the periodic table, occupying considerable text space. Another copy of the table is found in an appendix. Significant space would be saved by simply referencing the table in the appendix for each element. McGraw-Hill's *Dictionary of Scientific and Technical Terms* (reviewed in Phytologia 67[2]:208. [1989]) would be a better purchase.

Information for Authors

Articles from all lines of botany, biographical sketches, critical reviews and summaries of literature will be considered for publication in PHYTOLOGIA. Manuscripts may be submitted either on computer diskette, or as typescript. Diskettes may be 5.25 inches or 3.5 inches but must be written in PC/DOS (MS/DOS) format or as flat ASCII files. Typescript manuscripts should be single spaced and will be read into the computer using a page scanner. The scanner will read standard typewriter fonts but will not read dot matrix print. Manuscripts submitted in dot matrix print cannot be accepted. Use underscore (not italics) for scientific names. Corrections made on typescript manuscripts must be complete and neat as the scanner will not read them otherwise. Language of manuscripts may be either English or Spanish. Figures will be reduced to fit within limits of text pages and therefore, should be submitted with an internal scale and have dimensions proportional to those for text pages. Legends for figures should be included in figures whenever possible. Each manuscript should have an abstract and key word list. Specimen citations should be consistent throughout the manuscript. Serial titles should be cited with abbreviations used in *Botanico Periodicum Huntianum*. References cited only as part of nomenclatural summaries should not appear in Literature Cited. Nomenclatural work should include one paragraph per basionym and must provide proper (as defined by the current *International Code of Botanical Nomenclature*) citation of sources of epithets and combinations.

Authors should arrange for two workers in the appropriate field to review the manuscript before submission. Copies of reviews should be forwarded to the editor with the manuscript. Manuscripts will not be published without review.

Cost of publication is currently $12.00 US per page for publication without reprints. Publication with 100 reprints is provided for $16.00 US per page, 200 reprints for $19.00 US per page. Page charges are due with manuscript and no paper will be published before payment is received in full. Reprints must be ordered and paid for in advance. Page charges will be determined on the basis of a typescript page (single spaced, elite type, 12 points, blank line between paragraphs) with all type inside a rectangle 143 mm (horizonal) by 219 (vertical), not including running head and page number. Title page should include title, author(s) name(s) and address(es). Two blank lines should appear above and below section headings (Abstract, Discussion, Literature Cited, etc.) in the manuscript. No extra charge is made for line drawings provided they conform to limitations of size and proportion for normal text. Halftones require an extra charge of $5.00 US per page.